

# **Bilingual Language Processing: The Role of Socio-Cultural and Linguistic Context**

*A thesis submitted to Indian Institute of Technology in partial fulfilment for the degree of Doctor of Philosophy*

*Submitted by*

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## DECLARATION

I hereby declare that the thesis entitled, “**Bilingual Language Processing: The Role of Socio-Cultural and Linguistic Context**” is my original work carried out in the Department of Humanities and Social Sciences, Indian Institute of Technology Guwahati, India, under the supervision of Dr Bidisha Som, Professor of Linguistics, Department of Humanities and Social Sciences, IIT Guwahati.

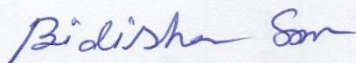
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26<sup>th</sup> August, 2022

## CERTIFICATE

This is to certify that the thesis entitled, “**Bilingual Language Processing: The Role of Socio-Cultural and Linguistic Context**” submitted by Opangienla Kechu for the degree of Doctor of Philosophy in Linguistics in the Department of Humanities and Social Sciences, Indian Institute of Technology Guwahati, embodies bonafide record of research work carried out under my supervision. All work in this study has been carried out by Opangienla Kechu herself and has not been submitted to any other institute/university for any degree or diploma.

A rectangular box containing a handwritten signature in blue ink that reads "Bidisha Som".

Dr Bidisha Som

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26<sup>th</sup> August, 2022

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## ABBREVIATIONS

AoA	Age of Acquisition
ACH	Adaptive Control Hypothesis
ANT	Attentional Network Task
AX-CPT	AX-Continuous Performance Task
BIA (+)	Bilingual Interaction Activation (plus)
DLC	Dual Language Context
ERP	Event Related Potential
FMRI	Functional Magnetic Resonance Imaging
IA	Interactive Activation
IC	Inhibitory Control
L1	First Language
L2	Second Language
LDT	Lexical Decision Task
LEAP-Q	Language Experience and Proficiency Questionnaire
RT	Reaction Times
SLC	Single Language Context
SRC	Stimulus Response Compatibility
TE	Translation Equivalents
TEA	Test of Everyday Attention
WEIRD	Western Educated Industrialised Rich Democratic

## CHAPTER 1. INTRODUCTION: SETTING THE STAGE



## 1.1. Situating Language

On the surface, language is a means of communication through which ideas, emotions and thoughts are expressed. In this sense, language is used not only by humans but also by a number of animals, starting from bees, crabs, whales to prairie dogs. Communication and cooperation are connected and prove important for survival in the animal kingdom. Science is yet to unearth the entire picture of 'language use' in the animal world as of today. However, human language and its many facets have been subject to scrutiny since long and we have come a long way to discover finer nuances behind simple language use at the neural, psychological and socio-cultural level. It was already well known that human language is unique because of the use of sounds to express situations at different contexts, arbitrariness between sound and meaning, the creative and productive ability of language users to produce an endless number of utterances/sentences and cultural transmission from one generation to another.

To start with, human language is intricately related to the society it belongs to. Each society has its norms and the language embody those norms and reflects the same. Both language and society influence each other to a great extent and so there is interaction between language and society. Social rules and norms dictate the way we use language i.e., the utterances we make. These utterances come from social construction of reality within the speakers, thus forming a community who encodes and shares knowledge through communication. Social norm of saying "Thank you" on receiving a gift is a good example. If one does not follow such social convention, one can be perceived as rude. The roles we play in society also influence language. For example, the use of formal and informal pronouns in some languages like German and Hindi. There are also terms of address in some languages like Ao, which are used to address another person by the speaker depending on the relationship he/she has with the speaker. Thus, in terms of language 'use', society and culture are an important aspect to remember.

Culture is defined as the distinguishing characteristics and thought pattern of a group of people, it encompasses every part of life like language, tradition, food, religion art and so on. The word 'culture' comes from the Latin term '*colere*' which means to grow something from the earth. Thus, culture is cultivated by a group of people together. Just as we are born into a society, we come in contact with that culture from birth. The cultural values of a community are not taught explicitly but through actions and through language. Through the process of language acquisition, cultural values are acquired and maintained and passed down from

generation to generation through language. One cannot learn a foreign language without learning their culture. For example, if someone learning Ao will find that there are lots of words for terms of address or kinship terms for various relationships. This shows that the Ao community values family ties and the subtle nuances within relationships. Language and culture are also dynamic and they change over time through contact. For example, if in the English language, one can see vast difference between the old English and modern English. We can also look at colonialism to see how much it has impacted languages and cultures around the world.

On the other hand, the nature of the language faculty, as to what it really 'is', at an abstract level, is yet another matter of interest. Through centuries, the human skill of understanding and expressing language, also called receptive and expressive 'knowledge' of language, has received a great amount of attention, with the primary focus often being 'meaning'. In the modern times as well, philosophers, psychologists, neuroscientists, alongside linguists, have contributed toward understanding these language functions, also called 'language processing'. It is now a common knowledge that language does not function in a vacuum; rather it is closely connected to other mental functions and is rooted in embodied experiences.

## **1.2. Chapter Overview**

This chapter introduces the key concepts investigated in the thesis. The point of departure for this study is to look at language processing among bilinguals, through its interaction with cognitive mechanisms and contextual influences. For this purpose, one needs to first look at what language is and what it does, beyond the mere communicative purposes. Language, following the Cognitive Revolution, is seen primarily as a higher mental function, working in tandem with other such faculties, like attention, executive functions and so on. Hence the focus has shifted from the analysis of the surface structures to how language is processed online, in a dynamic fashion, on the go. This underlines what goes on in the human mind when one either comprehends or produces language; the factors responsible behind the scene, that regulate how one processes language. Hence, this chapter first discusses the relationship between language and human cognition and the influence they have on each other. Following this, the notion of bilingualism, bilingual language processing and the various models of bilingual language processing that have been developed over the years are discussed. After setting the background, the current trends in bilingualism research are discussed, with special

focus on the role of context in bilingual language processing. The chapter then discusses the goals, objectives and research questions for the present study and positions them in terms of the gaps in literature and how this study can help contribute toward answering some of the current questions in bilingual processing literature.

### **1.3. Language as an Important Aspect of Human Cognition**

Language provides a window to the nature of cognitive functions and how thoughts and ideas are structured and organised. Language has two key functions, i.e., the symbolic function and the interactive function. Language use ‘symbols’ to encode and externalise thoughts and ideas. Symbols can be meaningful parts, morphemes of words like ‘*un*’- in *unfaithful* or words like *eat, sleep, play* or strings of words like ‘*How are you today?*’ Thus, a symbol has a form and meaning. The meaning is associated with a concept and concept in turn to perception. Perceptual information is derived from the world and it integrates into a mental image giving rise to a concept. Thus these meanings refer to our projected reality (Jackendoff 1983) which is a mental representation of reality as construed by the human mind, mediated by our unique perceptual and conceptual systems. We use language to communicate i.e., the interactive function in which the speaker utters the forms and the hearer decodes or interprets. These forms and meanings must be recognised and accessible to both the speaker and hearer for successful interaction. In other words, they have shared knowledge.

Since the 1950’s, there has been much debate about language and its relationship with cognition. It started with Chomsky’s approach to innateness. This approach is called nativism which states that certain language traits are inborn in the mind of every human being. These inborn language traits should be specific so as a person can learn any language spoken around him/her but also flexible so that a child of any ethnicity from any parts of the world can learn any language that is spoken around him. He called these traits as Universal Grammar. Chomsky was of the view that language learning and cognition are independent of each other and gave importance to syntax. Chomsky proposed rules and parameters (Chomsky, 1981) which gives the idea of language grammar to be modelled by parametric rules in the universal form and specific characteristics for the grammar of a particular language. In 1995, Chomsky came up with the idea called the ‘minimalist program’ which modelled language closer to meaning but he still was of the view that meaning and language were independent and still

gave importance to mathematical logic. He was of the view that language was separate from other mechanisms of the mind.

Though Chomsky was the first, among linguists, to popularize the idea of innateness of language, he was not the only one or the first one to do so. One important name in this regard is that of Karl Lashley, 1951 who opposed the then prevalent theory of 'behaviourism' by saying that complex mental functions like language needs a complex hierarchical structure, with 'intention/planning' at the highest node and syntax and actual production at the lower nodes. The nervous system has the entire structure containing the individual units. Thus, he recognized language as a mental function and connected the same with other processes like intention.

Later developments in this field came to emphasize more on a real time dynamic relationship between body, brain and the world; the embodied understanding of the world. Language processing also started to be investigated in this new light. Cognitive linguistics is one such domain that emerged from this development in the 1970's and rejected Chomsky's idea of separation between language and cognition. Cognitive linguistics emphasises the importance of human experience. One unique feature of the human language is that it is passed down from generation to generation and language is shaped by this process. It is embodied experiences. According to the empiricists, human experience is embodied and language cannot be examined without human experience. As discussed earlier, we understand the world around us through concepts and there has to be shared knowledge between the speaker and hearer for successful interaction. Metaphors are a good example, the phrase "*Kick the bucket*" to a non-native English speaker may mean the actual kicking of a bucket. Whereas for native English speakers, it means 'to die'. Thus, if this knowledge is not accessible to both the speaker and the hearer, there will be miscommunication. This also shows that not all phrases in a language follows the same rules of syntax and meanings of words. According to Sapir-Whorf hypothesis, also known as linguistic relativity (Whorf 1956), speakers of different languages have different ways of thinking, understanding and acting in the world. This Whorfian thought that language entirely determines thought and action was abandoned by linguists. But in the recent years, there has been a resurgence of interest in linguistic relativity. The evidence for linguistic relativity can be found in researches on space or spatial relations (Bowerman 1996, Levinson 1996, McDonough et al. 2000), time (Scott 1989, Boroditsky 2001), grammatical distinction between objects and substances (Lucy and Gaskin 2001) and grouping of names of objects into grammatical categories, numbers, colours,

shapes and events. Much like Cognitive Linguistics, other domains of language research also took an 'embodied' turn. Psycholinguistics, which is primarily an experimental domain, looked at language processing as being closely related to other cognitive processing. Language production and comprehension are one of the most complex human cognitive skills and both the processes require several complex processing steps. For production, the speaker has to select the appropriate concept, the appropriate word and sounds to convey his message. In comprehension, words either in spoken or written are taken in and decoded, linked to stored knowledge and then used to interpret. Thus, these processes involve planning, activation, selection and combination. These processes are also used in other tasks that are domain-general abilities and that interaction happens between language processing and other cognitive processing. More research findings point out that language and cognition are intertwined, however, the exact nature of the relationship is still being investigated, with newer aspects of this connection revealed every day.

#### **1.4. Language Processing as a Part of Cognitive Processing**

In the domain of experimental psycholinguistics, 'language processing' is used as a cover term that includes various linguistic operations in the domain of comprehension and production. Each of these domains is further divided into multiple sub-domains. Comprehension, for example, is studied both at lexical/word and sentential level. Word comprehension, again, comprise of spoken word comprehension and printed word comprehension. Similarly, production has spoken word/sentence and written word/sentence production.

Initially, language processing, both word level and sentence level, were thought to be autonomous, under the influence of *modular* view of Chomsky. This idea proposed that the initial level of processing of words and sentences work without any connection to higher level of knowledge, like world knowledge or context. Thus, this is a serial process. On the other hand, interactive models of language processing propose that many types of information are processed in parallel, like the phonological, conceptual factors etc.

Below various *types* of language processing, taking into consideration the theories and models that have shaped the discourse in these domains are discussed in brief. This will put in perspective the current research and its position in the domain.

### 1.4.1. Spoken Word Recognition

Recognizing spoken words comes as naturally to a speaker of that language as breathing. This is possible and easy even though there are errors, change in sounds due to the phonological environment, colloquial coinages (*going to* becomes *gonna*) and so on. Dominant models regarding this processing type support the interactive notion of word processing. For example, cohort model (Marslen-Wilson and Welsh, 1978) proposes a direct influence of the higher processing levels on the lower ones, in a 'top-down' manner. If a person hears the sentence 'pick up the candle' (Allopenna, Magnuson, & Tanenhaus, 1998), the candidate word 'candle' activates all possible words that share the initial phoneme. Hence the participants looked at 'candy'. As the processing of the word progresses, the irrelevant candidates will fade away and only the best fit match will be settled upon. Thus, there is a continuous mapping between spoken input and lexical representations, where the initial portion of the spoken word activates a set of probable candidates. Later works show that this mapping continues well into the last phoneme and beyond.

Modular models, like the *race model* (Cutler and Norris, 1979; Norris, McQueen, & Cutler, 2000) have not been as successful in accounting for the phenomena of parallel activation as seen in experimental set up, like the ones showed by Allopenna and others.

Though there are debates on finer aspects of the processing pathways, basic assumption that the knowledge of language and its patterns do help in spoken word recognition is generally agreed upon by researchers today.

### Visual Word Recognition

In comparison with speech, reading and writing are fairly new activities for humans. Reading i.e., orthography activates phonological information. Connectionist models propose that all phonemes of a word are activated in parallel, but *dual-route theories* (Ellis & Young, 1988, Coltheart et al., 1993, Perry et al., 2007, 2010) propose a serial order fashion, where the leftmost elements are worked upon first and it gradually moves as reading progresses (in English, for example). Latest techniques of non-behavioural methods like eye tracking (Rayner et al., 2004, Rayner et al., 2006, Leinenger et al., 2017, Kim et al., 2019, Parshina et al., 2021) have contributed to a great extent towards understanding comprehension of printed words, along with the behavioural methods like lexical decision task or naming tasks (de Groot & Nas, 1991, Dijkstra et al., 1999, Van Hell & Dijkstra, 2002, Lemhofer & Dijkstra, 2004, Lemhofer et al., 2008, Peeters et al., 2013, Cosmena et al., 2015, Poort, Warren &

Rodd, 2016, Poort & Rodd, 2017). And the findings point out that visually presented linguistic input also makes a rapid contact with the representation in the mental lexicon, the processing strategies of both types of processing are much the same.

### **Sentence Comprehension**

Much like word processing, sentence comprehension also has had its fair share of debates in terms of how the process actually works. There are serial models and interactive models in this domain too. The serial models (Frazier & Rayner, 1982; Pritchett, 1992; Ford, Bresnan, & Kaplan, 1982) propose that the processor creates representations of a sentence based on strict grammatical information. After that, interpretation and evaluation ensue using full range of information that might be relevant. But the other models (MacDonald, Pearlmutter & Seidenberg, 1994; Tanenhaus & Trueswell, 1995), mostly connectionist, say that interpretation happens quickly, using all relevant information at the same time. Both of these lines of theories have been updated in recent times and are useful in their own right, toward furthering our understanding of sentence comprehension.

Overall, the basic premise of language comprehension is that the listeners need to map the spoken or written input onto entries in the mental lexicon and must generate various levels of syntactic, semantic, and conceptual structure (Perfetti, Landi, & Oakhill, 2005, Lenhard & Schneider, 2006, Castles et al., 2018, Karageorgos, Müller, & Richter, 2019).

#### **1.4.2. Production**

In case of language production, the opposite of comprehension happens. The speaker here needs to map the conceptual structure onto word and its elements. There are stages of this process and all current models of word production agree on a three-stage process: conceptual processes, word retrieval, and articulation. The first stage refers to the decision-making process as to what the speaker needs to express. For example, to refer to a woman, one can say 'Ms Verma', 'Lila', 'the lady', 'she' and so on. The choice of that time will depend on various linguistic and non-linguistic/ social factors, followed by word retrieval and finally, we articulate the word suitable for the scenario. Thus, processing starts with conceptual level and ends in articulation. Like comprehension, production models are also of two types: those who prefer a serial processing and those that prefer a cascading effect. In the former, one level of processing needs to complete in order to move to the next level. But in the latter, each activated unit can spread activation to its subordinate levels (Humphreys, Price, & Riddoch, 2000; MacKay, 1987).

## **Word Production**

The study on word production started in the 1960's by psycholinguists who started collecting and analysing speech. The earlier theoretical models on word production were designed to analyse the patterns of errors in speech production. One of the most influential among the earlier models is that of Dell's two-step interactive activation model. According to this model, activation spreads from the semantic nodes to corresponding lemma or word nodes which in turn activates the phoneme nodes. All connections are bi-directional in this type of model and so they are called interactive. However, since the early 1990's, researchers have embraced unidirectional models that postulates non-existence of interaction between the various modules or processes during production. Within the unidirectional models of language production, Levelt's model (Levelt, 1989, Levelt et al., 1993) is the most widely accepted and influential model. Levelt proposes three components responsible for word production: the conceptualizer, the formulator and the articulator. The conceptualizer is responsible for generating and monitoring messages. The formulator takes care of linguistic structures like grammar and phonetics that best corresponds the message to be said. The next component is the articulator, which involves motor execution of the linguistic structures planned in the formulator. In this type of model, there is no interaction between the components and the information is only fed forward from one component to another. This model has been adapted by many researchers in the following years even in the field of bilingual language production and comprehension.

## **Sentence production**

Sentence production involves conceptualizing the message, accessing the relevant lexical items, building the sentence which includes sequencing the lexical items into grammatical sentences, morphophonological process and articulation. As opposed to the serial models discussed in the previous sections, the connectionist model, also referred to as the Interactive Activation (IA) model, contends that there is bidirectional interaction between the levels (Dell, 1986, Martin et al., 1984). Thus, this model proposes serial processing. Another later model by Chang et al., 2006 proposed a dual-path model of sentence processing. This model divides the sentence production system into two parts, i.e., the meaning system and the sequencing system. The association between a message and thematic roles of different lexical concepts is learned by the meaning system, whereas sequencing those thematic roles and inserting morphosyntactic markers is learned by the sequencing system. The model is based on syntactic acquisition by children as well as structural priming. Thus, the model emphasises

the relationship between the acquisition of syntactic knowledge and the use of this knowledge in sentence production.

Whether language production involves serial processing, parallel processing or both, all models describe the crucial levels involved in the process, i.e., conceptualizing the message, activating relevant lexical items, syntactical process, morphophonological process and articulation.

In the recent years, a mountain of evidence has emerged on the influence of cognitive process in language comprehension and production. This influence can be seen in executive functions and attention, which are domain-general cognitive processes and verbal working memory which are domain-specific mechanisms (Shao et al., 2012). Therefore, future models on language processing should include the inter-relationship between language processing and cognitive processing which could lead to better understanding of the language comprehension and production processes.

## **1.5. Bilingualism**

Bilingualism is a common phenomenon all over the world and has been in existence since the beginning of language in human history. Bilingualism refers to the use of two or more languages regularly. Leonard Bloomfield (1933) defines bilingualism as “the condition in which the two living languages exist side by side in a country, each spoken by one national group, representing a fairly large population of the people”. More recently, Grosjean (1992) defines bilingualism as “the regular use of two (or more) languages, and bilinguals are those who need and use two (or more) languages in their everyday lives”. Over the years, scholars and researchers have struggled to come to a common definition of bilingualism, the types of bilingualism and its effect, positive or negative on an individual and the society as a whole. Some have defined bilingualism as simply having the knowledge of two languages (Bloomfield 1933) whereas others have defined it as the use of two languages (Grosjean). Initial definitions on bilingualism included notions of when the two languages were learnt, thus being a subordinate, coordinate or complex bilingual. But more current ones take into account how well the speakers perform tasks that are cognitively demanding, in both languages. Over time, discussions on bilingualism in the scholarly circles have focused on a myriad of issues such as social, cultural, cognitive, psychological, developmental,

educational and even political aspects, alongside the obvious linguistic factors. Similar diversity is found in defining types of bilinguals as well. Apart from the variation on the basis of when the languages are learnt, we now have categories based on Age of Acquisition, proficiency, usage patterns, language dominance, migration status and so on. Despite differences in defining bilingualism, the types of bilingualism, its effects and the question of who is a bilingual, the fact remains that knowing more than one language will put an individual in a better position in today's world. Being able to communicate with more than one group of people across the globe will give a person the advantage of not only communication but new ways to think, learn new ideas, cultures and its intricacies.

## **1.6. Biculturalism**

The changing face of our understanding of bilingualism as a linguistic phenomenon is captured by the term 'biculturalism' (Grosjean 2008; Nguyen & Bennet-Martinez 2007); this term reflects the level of interaction a bilingual has with the cultures representing his/her two languages. Biculturalism is, often though not always, found to co-exist with bilingualism. This phenomenon is defined as a scenario where the bilinguals take part in the life of two or more languages, and in the process learn/adapt the attitudes, values, cultural nuances of both the languages. Not all bilinguals are bicultural; for example, people of many western European countries like the Netherlands, Germany etc. They might be Dutch-English/German-English bilinguals, but live in Dutch/German culture. Similarly, biculturalism may exist without bilingualism like the British people in USA. However, a large number of bilinguals are bicultural, especially in Asia, Africa, Latin America as well as Europe. As a result, this factor is receiving increasing attention in the domain and has become yet another variable in defining types of bilinguals. Research has, similarly, started to factor this in, in terms of both experimental and observational studies (Grosjean & Byers Heine, 2018).

## **1.7. Bilingualism Research: Broad Areas**

As early as the 1920's, studies began on the relationship between bilingualism and intelligence. Bilingual children were found to be inferior than monolinguals in various linguistic areas like, vocabulary (Graho 1931), poor writing and grammatical skills (Saer

1923). It was also found that bilingual children were cognitively inferior in both verbal and non-verbal intelligence test (Arsenian 1937; Darcy 1946). This led to the belief that bilingualism had a negative impact on a child's intellectual development. However, most of the studies prior to 1960 did not account for socio-economic difference. The lower performing bilinguals belonged to lower socio-economic background and higher performing monolinguals belonged to high socio-economic background (Fukuda, 1925). Besides, bilinguals vary in degrees of proficiency, age of acquisition, education etc. Therefore, it is essential to take into account such variables while researching on bilingualism/bilinguals.

In a now landmark study, Peal and Lambert (1962) took into account children's self-rated second language ability and controlled the difference in age, sex and socio-economic status. They also used three tests to determine if the children were equally skilled in both French and English (balanced bilinguals) or monolinguals. Contrary to the previous studies, their results showed that the bilinguals performed significantly better than monolinguals in all types of verbal and non-verbal intelligence tests. Similar results were found by Ben-Zeev (1977). Peal and Lambert's distinction between balanced bilinguals and bilinguals who use one language more than the other (pseudo-bilinguals) have led researchers to be more careful in selecting their participants and has made a significant contribution to the methodology in the field of bilingualism research. The new era of bilingualism, the 'cognitive science period', started with Lenneberg (1967), Luria (1970, 1976, 1979) where the focus was shifted to the evaluation of language in terms of physiological examination. In the past few decades, the focus has shifted on language and its effects on brain functions and has seen immense growth from the Revised Hierarchical Model (Kroll and Stewart, 1994), Bilingual Interaction Activation Model (BIA, Dijkstra and Van Heuven, 1998), Inhibitory control Model (Green 1998) to the recent Adaptive control hypothesis (Green and Abutalebi, 2013). The Adaptive Control Hypothesis specially has gained much traction with researchers finding compelling evidence (Hartanto & Yang, 2016, Verreyt et al., 2015) for the importance or interactional context on bilingual language processing. In tandem with this is the research on the influence of cultural context on language processing which first started a decade ago and is still continuously finding evidence. Thus, the main emerging trend in bilingual language processing research today is on the influence of context, be it linguistic context or non-linguistic context like culture.

### 1.7.1. Models of Bilingual Processing

In section 1.4 various models of language comprehension and production were discussed which mostly dealt with monolingual language processing. Those models were further adapted by researchers in an attempt to understand bilingual language processing. In this section some of the relevant and influential models of bilingual comprehension and production are discussed.

#### Language Comprehension

##### *The Revised Hierarchical Model (RHM)*

The Revised Hierarchical model was proposed by Kroll & Stewart (1994) is a hierarchical model, i.e., it proposes two independent lexicons for each language and an integrated conceptual system. The predecessors of this were the ‘concept mediation model’ and the ‘word association model’. The RHM sought to bring in further nuance into the understanding. The core assumptions of the model are that the links to the conceptual systems are stronger in case of L1 lexical items and the link between the L2 lexical items and the conceptual system grows stronger as the bilingual becomes more proficient in their L2. For low proficient bilinguals, the conceptual system is accessed through L1 translations. Figure 1.1 shows the links between the conceptual structure and the language nodes. This model captures the relationship between conceptual structure and lexicon and also the relationship between the languages and learners’ proficiency.

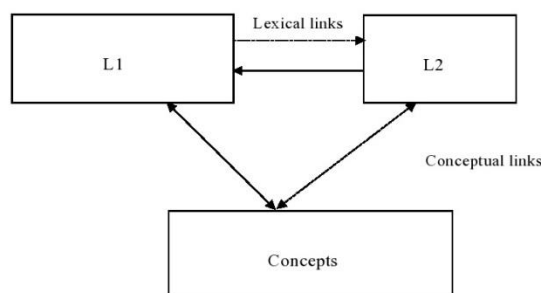


Figure 1.1. Revised Hierarchical Model

### The Bilingual Interactive Activation (BIA) and BIA+ Models

The Bilingual Interactive Activation (BIA) model proposed by Grainger and Dijkstra (1992) is a connectionist computational model with its base on the Interactive Activation (IA) model (McClelland & Rumelhart, 1981). According to the BIA model, words from both the target and non-target languages are activated when a cue is presented. Similar words are activated in both the languages and these words send activation to the language nodes. The inhibition of a language depends upon the strength of activation of the language node of the other language. The stronger the activation of the language node, the greater the inhibition of the non-target language. This model differs from the RHM that the lexical items of the two languages are stored in an integrated lexicon and they both get activated in a non-selective manner. Figure 1.2 shows the various levels involved in bilingual language processing according to the BIA model.

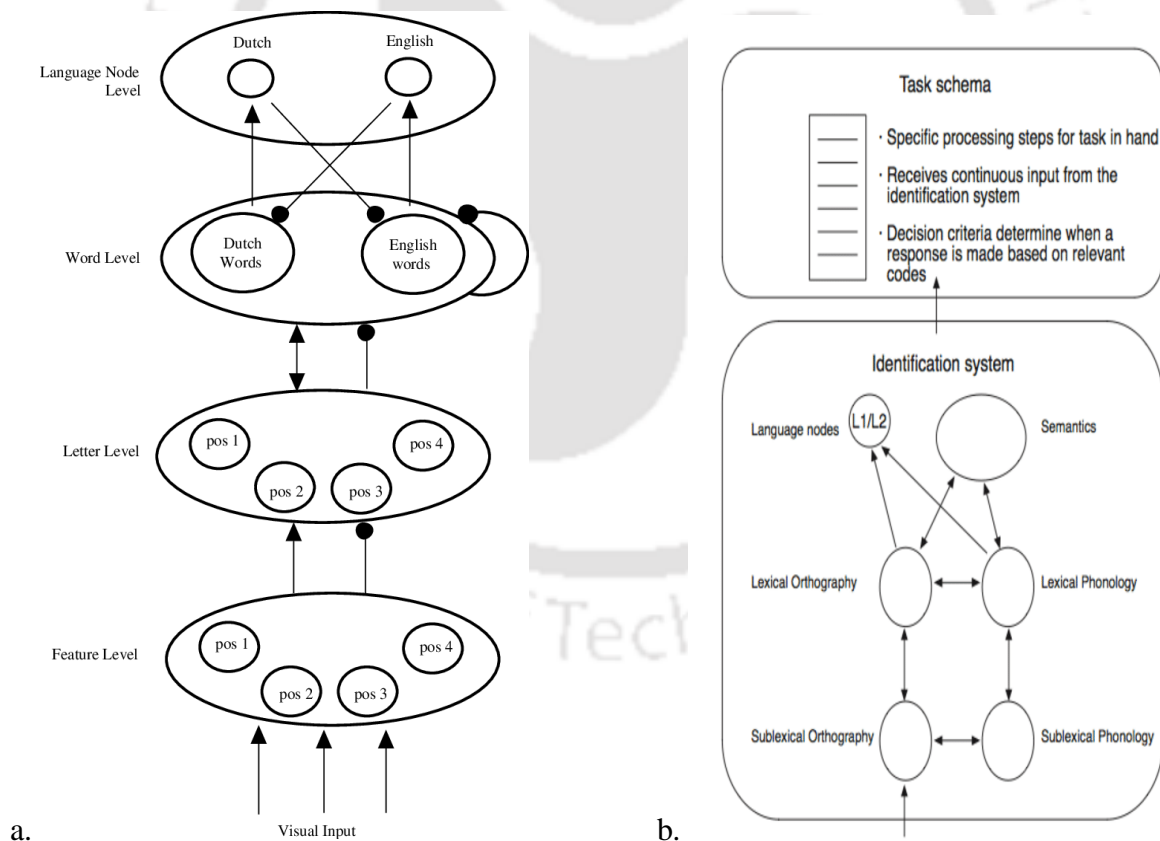


Figure 1.2. a. Bilingual Interactive Activation Model (BIA) b. BIA+ model

## **Speech production**

Models of bilingual speech production is generally divided into two views i.e., selective and non-selective lexical access. According to the selective view, selection happens at the conceptual level, activating lemmas or nodes only in the target language (Poulishse & Bongaerts, 1994, Hermans, 2000). On the other hand, the non-selective view is that lexical items of both the languages gets activated simultaneously. Thus, language selection does not occur at the conceptual level. Language non-selective view is mainly supported by research on bilingualism. The manner in which the selection happens is also highly debated with two viewpoints: language specific selection and language non-specific selection. Language specific selection view says that lexical candidates from both languages gets activated when a bilingual intends to speak in a language. The candidate in the target language is finally considered for selection with no interference from the non-target language (Costa et al., 1999). Contrary to this the language non-specific selection, proposes that in addition to the simultaneous activation of both the target and the non-target language, lexical items from both the languages compete for selection (Hermans et al., 1998). For the target language to be selected, the selection process has to go through further processes like inhibition of the non-target language.

### ***Adaptive Control Hypothesis (ACH)***

A theoretical position that combines the context of language use with that of its impact on the cognitive advantage is the Adaptive Control Hypothesis (Green & Abutalebi 2013); this theory emphasizes the dynamic role of cognitive control in bilingual language use and the role of context on that control mechanism. The hypothesis proposes that the different interactional context of bilinguals place varying degrees of demands on language control of the bilinguals. Green & Abutalebi discusses three interactional contexts, i.e., the single-language context (SLC) in which bilinguals use only one language in one context, the dual-language context (DLC) in which bilinguals use two languages in the same context and dense-code switching context in which code-mixing happens routinely. In this line, a recent study investigated the role of bilingualism on cognitive control among bilingual interpreters, a group of people with very high degree of demand on their language control. However, they (Linden et al. 2018) did not find any difference between high proficient bilingual interpreters and monolinguals in various tasks representing cognitive control. No enhanced conflict resolution, attention and updating in this bilingual group was put down to the fact that the interpreters may not use their two languages like other bilinguals.

While language control involves two types of processes, i.e., proactive and reactive language control, most models of bilingual language comprehension like the BIA (Grainger & Dijkstra, 1992) seems to be deal with proactive language control. However, ACH accounts for reactive control and proposes some theoretical foundations for both proactive and reactive language control. The framework proposes that executive functions like goal maintenance, conflict monitoring and interference suppression could be viewed in the context of proactive and reactive language control.

### **1.7.2. Current Trends in Bilingual Processing: Cognitive Control & Bilingual Experience**

In recent times, research in the domain of bilingualism has focused on the issue of ‘bilingual advantage’. Bilinguals face a continuous competition between the representations of first and second languages during any linguistic task, be it reading (Van Assche, Duyck, Hartsuiker & Diependaele, 2009), listening (Lagrou, Hartsuiker & Duyck, 2011) or speaking (Hermans, Bongaerts, De Bot & Schreuder, 1999). A proficient bilingual is adept at resolving this conflict through a very sophisticated inhibitory control mechanism in place, which seem to be domain general. This is what is widely known as the ‘bilingual advantage’, referring to the better performance of bilinguals as opposed to monolinguals on non-verbal tasks that ‘require different cognitive control processes, like conflict resolution, attention, shifting, updating, and working memory’ (Bialystok, Craik, Grady, Chau, Ishii, Gunji & Pantev, 2005; Bialystok et al., 2006; Costa et al., 2008; Prior and Macwhinney, 2010; Luo et al., 2013; Pelham and Abrams, 2014; Prior and Gollan, 2011; Wiseheart et al., 2016); Colzato, Bajo, Van den Wildenberg, Paolieri, Nieuwenhuis, La Heij & Hommel, 2008; Costa et al., 2008; Martin-Rhee & Bialystok, 2008). However, there are also ample number of studies that show that such a claim is questionable at best (Morton and Harper, 2007; Hilchey and Klein, 2011; Paap and Sawi, 2014; Paap et al., 2015; Ratiu & Azuma, 2015; Paap & Greenberg, 2013; Paap et al., 2017). A number of researchers (Noort 2019; Bruin, 2019) have pointed out that both individual as well as methodological factors appear to modulate this difference in outcome. While on the methodological side, the advantage is seen in specific task conditions requiring inhibition, it is the individual factor that is of greater interest for the current study.

The individual factor is made up of a number of components like proficiency, age of acquisition (already investigated in depth), ethnic and socio-economic background, the

context of language acquisition, language use as well as language switching (voluntary Vs. controlled). Together these factors can be called the ‘bilingual experience’. The bilingual experience has an important role in bilingual language processing and cognitive control (Blanco-Elorietta & Pylkkänen, 2017; Bruin, Samuel and Dunabeita, 2018; Zernstein, Bice & Kroll, 2019) because while bilingualism itself is common, the circumstances of bilingual acquisition and use are diverse.

Given these factors, the context of bilingual language use has been much in focus of late. Researchers now agree that the need of the hour is to move away from finding proof for either the existence or non-existence of bilingual advantage with respect to monolinguals and investigate the nuances within bilingualism that may result in variations in cognitive control. In other words, bilingualism as a concept needs a closer look in terms of its components and hence there is a need to study different types of bilinguals. There is a growing consensus [Linden et al 2018; Zernstein et al 2019; Dussias et al, 2019] that researchers need to take into account the various ‘types’ of bilingualism to better understand its effect.

Thus, one can see that though many earlier studies have focussed on the advantages of bilinguals over monolinguals (Bialystok et al., 2007; Costa et al., 2008), recent research has focussed on the other aspects of within-bilingualism variables like proficiency (Singh & Mishra, 2013, Weber et al., 2015). Few studies (Hartanto & Yang, 2016, Verreyt et al., 2015) have also provided evidence for the importance of context as addressed in the Adaptive Control Hypotheses (Green & Abutalebi, 2013). Similarly, culture as a factor that influences cognitive functions is a fairly new interest in bilingualism research. Evidence of culture as a determining factor have been reported in many studies (Zhang et al., 2013, Yang & Yang, 2013) although there have also been some mixed reports (Som et al., 2018). Nele Verreyt et al., 2015 (182) puts the case clearly: “...that most of the reported bilingual advantage reports indeed come from a very specific and limited number of bilingual populations, suggests that the bilingual advantage does not emerge from bilingualism in itself, but instead that certain characteristics of language use may be crucial for development of the control advantage. Currently, however, it is unclear what these language use/learning factors are”. This sets the tone of the current work as it undertakes investigation into the existence and nature of cognitive control mechanism in a type of population hitherto not looked into, looking at a particular aspect of bilingual experience that is common in many societies like in India.

## **1.8. Effect of Context on Bilingual Processing**

In the process of speaking, reading and writing, bilinguals constantly activate the target language and inhibit the non-target language. Thus, bilinguals exercise great cognitive control while switching from one language to another. Though there have been many studies that looked at linguistic context and bilingual control, not many studies have looked into the non-linguistic context of a bilingual and its effect on bilingual executive control. A potential factor that could modulate language control in bilinguals is the cultural context in which language use occurs. Word meanings of a language may be connected to culture-specific knowledge and this may also contribute to language selection process (Dong et al., 2005; Pavlenko, 2009). Previous studies present conflicting results, with some studies showing that non-linguistic cues had effect on control mechanisms (Yang and Yang; Zhang et al., 2013; Li et al., 2013; Liu et al., 2018) while others seem to have found mixed evidence (Roychoudhuri et al., 2016). Could the difference on cultural context have an effect on bilingual control? The Adaptive Control Hypothesis (Green and Abutalebi, 2013) talks about the different levels of demand placed by the interactional thus modulating language control. Recent studies (Timmer et al, 2019; Liu et al., 2020; Rafeekh and Mishra 2021) have found support for this theory.

### **1.8.1. Cultural Context**

Bilingualism and culture are closely associated and both influence each other. Bilinguals learn about the culture while learning the associated language. Some become bilinguals by immersing in an environment where they have to learn another language apart from their mother tongue. Most often in such cases, the second language is associated with high status and the first language with low status. Some are bilinguals because of inter-cultural marriages. In such cases, the children learn both languages and culture at a young age and can internalise both the cultures as their identity. This complex link between culture and language is important in the study of bilingualism. Many studies have shown that there is a disruption in L2 in the presence of L1 cultural/iconic images (Zhang et al). However, these studies only looked at the immigrant population in western countries where the L2 (English) is already at a higher rung in the language ladder than the L1. If we look at the immigrant population in those countries, the parents encourage the children to learn and only speak English as soon as they reach the country. The parents do so because of various socio-economic reasons. They think that their children will be able to get better jobs if they are able to speak English and

hence gain economic stability leading to overall better social life. Thus, L1 is told to be suppressed and L2 enhanced. Hence, the findings in such studies could be a result of lifelong practice of suppressing L1 and not because of the presence of L2 cultural/iconic images. Are such practises prevalent in other parts of the world where bilingualism and biculturalism are a norm and not an exception? Would we find the same results in these countries? Most countries in the eastern part of the world have a mixed population with different cultures, traditions and languages. Take for example, India with 415 languages (SIL Ethnologue) and Hindi and English as the official languages according to the Indian constitution. India has 28 states and 8 union territories and each state and union territories have the liberty to specify their own official language/languages. Within these states, there are various communities who have their own languages and within the communities, there are dialectal differences. People from such countries are often bilingual/multilingual in a more organic way than those immigrant population from the western countries. English still holds a higher status in these countries as well because of colonialism but English is not the only reason that people are bilingual. Because of the cultural and ethnic diversity, people have learned to co-exist side by side and assimilate each other's culture and with that, the languages as well. Hence, people become bicultural and bilingual through mutual coexistence. However, there is no denying that fact that in some parts of the country, for political and economic reasons, some languages are forced upon the people and language has also been used for political gains. Although the communities/ groups maintain strict cultural identity, some similarities between groups can be seen due to years of coexistence. Thus, from such population we might get different results as they are not living in a place far from their native culture and language and not immersed in an L2 environment. Different bilingual groups with different cultural background might react or respond differently to cues in a task and in bicultural bilingual group there could be parallel activation of both languages (Lagrou et al., 2011).

As stated in Bak (2014) bilingualism in itself is very complex with diverse experiences and investigations into societies with more complexities like that of multilingual societies with diverse cultural practices like India and Singapore, may add valuable contributions to the bilingual language processing research in the context of 'real world bilingualism' (Zernstein et al. 2019). Studies that represent societies outside Western, Educated, Industrialized, Rich and Democratic (WEIRD) category are less and they may add new insights about bilingual processing and its results on a much larger number of people. Many countries have population that are essentially bilingual at the very least and multilingual in general. Often

the languages known to them are not formally learnt but are picked up in social context, just as a matter of mutual convenience or historicity. In such societies, like in India for example, one's awareness of the others' language/culture is part of the subtle nuances of daily conversations. Minute cues are taken care of while conversing, as evident from code-mixing and code-switching practices. The listeners/interlocutor's identity is rather relevant, and thus salient, in such societies for pragmatic purposes. In fact, the interlocutor's role has already been investigated as a significant predictor of the bilingual behaviour in many studies (Martin, Molnar & Carreiras, 2016; Li et al., 2013; Zhang et al., 2013; see also Kroll & McClain, 2013).

### **1.8.2. Linguistic Context**

Bilinguals' ability to switch from one language to another has been studied extensively to understand the mechanisms of language control. Language control for bilinguals is the ability to keep the two languages apart, avoiding interference and selecting the target language in a given interactional context. Not all bilinguals are the same and they vary in various dimensions like age of acquisition, proficiency etc. Thus, bilingual experiences are unique from person to person, country to country. To know how these experiences modulate language control, it is important to understand the cognitive influences of bilingualism. The relationship between language control and cognitive control is very much a recent area of bilingualism research with mixed evidence of bilingual advantage over monolinguals (Bialystok et al., 2004; Costa et al., 2008; Bialystok et al., 2012) and contradictory evidence (Dunabeitia et al., 2014; Paap & Greenberg, 2013; Paap & Sawi, 2014). Recent studies have shown that there are other factors like interactional context which modulates language control (Hartanto & Yang, 2016).

In the recent years there has been mounting evidence for the influence of bilingual language switching context on executive control and a theoretical framework that seeks to explain this phenomenon is the Adaptive Control Hypothesis (Green & Abutalebi, 2013). The hypothesis describes three language contexts that come with different cognitive demands and processes. The *single-language context* (using the two languages separately, e.g., one language at home and one at work) is argued to demand cognitive processes such as goal maintenance and ongoing inhibition of the non-target language. The second, *dual-language context* (in which bilinguals use both languages in the same context, but with different speakers) is argued to require various control processes including conflict monitoring, interference suppression, selective response inhibition, and task dis-engagement. Language switching takes place

frequently in this context. Switching also takes place frequently in the third, *dense code-switching context*. However, in this context bilinguals can freely switch between languages and can use an opportunistic planning approach using words that are most easily available regardless of the language. Thus, this type of switching may require relatively little cognitive control. Language use in bilingual speakers increases the demand on the processes involved in utterance selection over and above those that are imposed on monolingual speakers. If control processes adapt to such demands, then this argument provides a basis for expecting possible advantages in the cognitive control of nonverbal tasks though it leaves open the mechanism involved. Due to the highest cognitive and linguistic control demands placed on the DLC (dual language context), the prediction within the ACH places much importance and attention to this context. Bilinguals living in a DLC environment who are constantly switching between the two languages would require a more taxing level of language control and therefore, they should be better at not only task switching performance than either the SLC (single language context) bilinguals or the dense code-mixing context bilinguals but they should also be able to suppress interference either linguistic or non-linguistic and thus be able to inhibit the irrelevant language more easily. Thus, DLC participants are predicted to be better at conflict monitoring and inhibitory control processes. Comprehension processes in bilingual speakers are relevant to the adaptive response. They may tune the system to detect critical features that discriminate one language from another (Krizman, Marian, Shook, Shoe, & Kraus, 2012; Kuipers & Thierry, 2010) and adapt processes that control interference between competing word meanings (Macizo, Bajo, & Martin, 2010). The ACH suggests that bilinguals' interactional context is a key factor that modulates cognitive advantages in Executive Function.

### **1.9. Objective and Rationale for the Present Study**

The existing literature points to a significant impact of external cues on language behaviour, as seen through inhibitory effect on the language processing in non-congruent conditions, facilitation in case of a congruent condition and so on. It was also found out that the impact of the cues have their limitation (Woumans et al., 2015). All this implies that the subjects, while automatically taking cues from the environment, are also capable of overcoming the same influences when they realize the cues may not be reliable. In other words, the impact is contingent upon many other conditions. This finding by Woumans are crucial because it

points to the possibility that the impact of cues is not automatic and the speaker's understanding of them is directly linked to how the same will impact their language selection/production. It would be a good idea to probe this further, in varied conditions. For example, one can consider how the time course and scope of this inhibitory mechanism may be modulated by cultural cues and how that modulation may depend on the context of language use. It is recommended by researchers that future research using finer-grained methods to investigate the impact of cultural cues on language processing will enable us to localize the observed effects. In Indian context, very less work has been done regarding contextual cues and its effects on bilingual language production. The experiment done by Indian researchers point out that different types of cultural cues might influence language selection differently depending on their salient values and importance. Their study shows cultural cues modulate language. Hence the language selection is claimed to be affected by language cues in the environment.

Secondly, a crucial gap in the existing literature in this domain is that almost all of the findings are from studies conducted on WEIRD (Western, Educated, Industrialized, Rich and Democratic) societies and it is not yet clear if they hold true for the global populations in general. Over reliance on research subjects from the US and other western nations can produce false claims about human psychology and behaviour because, for one, this is a very small number of people and hence cannot be taken as the representative of the human population everywhere. Heterogeneity marks human communities all over the world, and it is quite possible that the same results will not be found if tested in a completely different population set and/or with strikingly different socio-cultural milieu. The majority of the researches and studies are conducted on subjects from western nations, primarily university students and immigrants who are highly proficient in their second language. It has been found that immigrants favour distinctive linguistic forms for heritage-culture reasons even when using mainstream language. It should also be considered that immigrants might not have sufficient exposure to L2 in the case of language processing. Since insufficient exposure to L2 increases L1 dependence, the recent immigrants who participated in researches and experiments with relatively low L2 proficiency should have been subject to greater L1 interference, especially when L1 representations were activated by cultural cues. Therefore, it is possible that the intrusion of L1 lexical structures in the production of L2 could be specific to bilinguals with low proficiency, but not to those with high proficiency. Researches in the

WEIRD societies and their non- WEIRD counterparts vary in a spectrum of key areas including visual perception, fairness, spatial and moral reasoning, memory and conformity.

Thirdly, bilingualism in the processing literature, seems in most cases, to be treated like a self-sufficient module, without giving too much importance to the social context of the practice. Hence, the cues, mentioned above, are almost always taken as ‘language cues’ and not socio-cultural cues. This idea can be explained as the language versus cultural distance between the speech communities. Languages that are spoken in close proximity may also represent culturally close communities and the opposite may also be true, i.e., languages that are vastly different may actually represent cultures situated far apart. For example, a Chinese-English bilingual is vastly and meaningfully different from a Dutch-German bilingual or a Bengali-Hindi bilingual. In some cases, the studies choose subjects immersed in L2 environment, but that does not change the inherent differences [e.g., Chinese population in US]. There is the possibility that these underlying differences will find a way to impact the results in bilingual language processing studies. In order to find the ‘global truth’ about the impact of culturally relevant cues on language processing, one needs to juxtapose findings from Chinese-English kind of studies with findings from language pairs that is culturally contiguous.

Fourthly, the interactional context of bilinguals differs from place to place and so their language switching practices are unique. The Adaptive Control Hypothesis seems to take into account this difference in the interactional context and many findings have indicated evidence in support of the hypothesis. However, much of these findings are again from western countries where bilingual language switching practises are quite different from countries like India where there is a fluidity in switching from one language to another due to wide-spread multilingualism. To truly understand the impact of interactional context, it is crucial that we study all form and types of bilingualism/multilingualism.

### **Research Questions and Objectives**

The overall aim of the study is to examine the role of context in bilingual language processing. In order to achieve that, the study investigated two areas that concerns with the role of context, i.e., cultural context and linguistic context.

In terms of the cultural context, as discussed in the section above, there is a need for research in places where there is a close contact between L1 and L2, where L2 is not distant as in the case of English and the cultures and languages co-exist. India provides a good example of such a possibility where language and cultures co-exist for centuries and where bilingualism is a norm and not an exception. India has a complex linguistic network and has generated bilingual or multilingual people with interaction between various linguistic groups. The complexity is even more visible in the Northeast India which is an area of ethnic super diversity. Each of the states in this region have their own distinct cultures and languages. Bilingualism prevails between intra-tribal and inter-tribal communities in this region. Therefore, it would be interesting to see how the contexts impact language processing within this set up. This study will try to look at pairs of languages from Nagaland (a state in Northeast India) and adjoining areas where the two languages are from two different languages and cultures. Moreover, the bilingual speakers are often bicultural in the Northeast Indian context, owing to the fact that these various groups have lived side by side for centuries. This kind of setting offers a unique opportunity to choose different bilingual groups, with varying degrees of social interactions with each other.

In terms of bilingual language switching context, although there is an increased understanding of the nature of mental representations and processes in bilingual lexicon, there is not much research on simultaneous bilingualism in India. Few researchers in other countries have studied Indian bilinguals (Bialystok and Viswanathan, 2009; Bialystok et.al., 2004) and few studies by Indian researchers have explored the cognitive mechanisms in Indian Hindi-English bilinguals (Mishra and Singh, 2014; Mishra and Singh 2015). This is another area where the Northeast Indian setting is interesting as many people here learn their L2 in social settings rather than in a formal one. As a result, it quite common to find near simultaneous bilinguals here. Depending on the social fabric and hierarchy among the languages spoken, the pattern of switching also changes.

Given the above discussed background, the current work proposes to investigate some of the finer aspects of bilingual language processing and its relationship with contexts of use, in some Northeast Indian bilingual groups. Primarily, better understanding of the ‘bilingual experience’, through careful choice of contextual cues, selection of bilingual groups based on factors of social relationships of different types, as revealed through different task conditions are the main focus of the study.

Within this broad goal, the specific questions for each domain of influence are as follows:

Issues related to the influence of cultural context:

1. Does the data from non-WEIRD population corroborate the findings from earlier studies?
2. If they are different, where does the difference lie?
  - a. Do cultures influence language processing?
  - b. If the L1 versus L2 cues have differential influence on the processing techniques, is it because of language dominance?
  - c. Is it possible, then, that the similar effects will not be seen in bilingual population that have lived side by side for centuries and hence have domain specific though not dominant versus non-dominant structure of language use?
  - d. If identity markers are a variable that impacts processing, is it only because of the languages they represent or the cultural/social relation between the representative groups are also important?
  - e. The earlier studies typically had subjects that learnt their L2 in formal set up. Will the results be similar if L1 and L2 were learnt simultaneously or at least, in close succession?
  - f. Will the socially learnt L2 show any difference in the processing technique?
  - g. Is there any urban/rural, educated/non-educated, old/young dichotomy on these issues?

Issues related to the role of linguistic context:

1. Does the interactional context modulate linguistic control and cognitive control?
2. What are the other factors that might modulate language control apart from interactional context?
3. Does the status of a language as L2/L3 have any role in this regard?

In order to address these issues, a series of linguistic and non-linguistic experiments were conducted with various bilingual groups. In total, there were 8 experiments - 4 for investigating the role of cultural context and 4 for linguistic context.

## **1.10. Thesis Structure**

The thesis comprises of six chapters.

Chapter 1 gives an introduction to language processing in general and bilingual language processing in particular to describe the background of the current study following which the goals of the current work are explained.

Chapter 2 provides the literature review on the role of culture and linguistic context and points out the gaps in the existing literature.

Chapter 3 gives a detailed account of the methodology used in this study. Various experimental processes like data collection, and data analysis etc are discussed here.

Chapter 4 describes the four experiments carried out to study the role of cultural cues on bilingual language processing in different groups of bilinguals.

Chapter 5 presents the experiments investigating the role of linguistic context on the processing.

Both chapter 4 and 5 include language related and domain general tasks to check the various facets of 'control' mechanisms used by the bilinguals.

Finally, chapter 6 concludes the study discussing the main findings from the experiments and their implications. This chapter ends with a note on future directions the study can inspire.

## **1.11. Chapter Summary**

The present chapter provided the basis of the current study highlighting the trajectory of language processing with focus on bilingual language processing. The chapter also gave an overview of the current trends in bilingual language processing research and positioned the research questions and objectives of the current study in that background.

## CHAPTER 2: LITERATURE REVIEW



## **2.1. Introduction**

In the last 20 years or so there has been an increasing interest in studies on bilingual advantage and the impact of bilingualism on brain functions. Bilingualism was found to aid in conflict resolution (Costa et al., 2008; Singh and Mishra 2013; Wu and Thierry 2013), attentional control mechanisms (Bialystok 2004) and aids in delaying cognitive decline in old age like Alzheimer's and dementia (Craik & Bialystok 2006). These advantages may result from the need of a bilingual to juggle two or more languages in everyday life resulting in cognitive flexibility. Apart from researches on bilingual advantage, the processing techniques used by a bilingual in production or recognition process have also been studied. It has been found that language selection and activation in a bilingual is not affected only by the linguistic factors (proficiency, dominance, language experience etc) but also by extralinguistic factors such as cultural cues (Zhang et al., 2013), faces or interlocutor's identity (Kapiley and Mishra, 2019; Woumans et al., 2015). These effects, again, differ between high proficient and low proficient bilinguals, in that the high proficient bilinguals are better at monitoring contextual demands than low proficient bilinguals (Abutalebi et al., 2013). These findings point towards the subtle nuances within the bilingual populations in terms of various linguistic and non-linguistic factors. The current thesis focuses on the effect of context on bilingual language processing. Contexts can be of different types, especially when one delves into what constitutes bilingual experience. The current work investigates two types of contexts that have been found relevant for the bilingualism research, namely cultural context and the language use context (linguistic context).

## **2.2. Chapter Overview**

This chapter presents a detailed review of the existing literature in this domain and after a careful critical analysis of the same, arrives at the gaps in the literature, justifying the current study.

## **2.3. Role of Cultural Context in Bilingual Language Processing**

The role of context in bilingual language processing, both the production and comprehension, is well attested, and the same is already discussed in Chapter one. Bilingual language

comprehension and production is affected not only by the linguistic factors but also by non-linguistic cues which includes interlocutor identity, iconic cultural images, flags etc. There is also association between language and culture which influences language selection. Thus, language use takes place in a rich cultural context, creating cultural priming and activation by association.

Socio-cultural background of a people/language is an important contextual cue that is taken into account in any language related task. Bilingual speakers are always aware of the subtle cues with respect to such information. The connection between language and its background are so intertwined that one may activate the other in the human mind. For example, faces can activate a language (Hartsuikar et al., 2015; Woumans et al., 2015) and similarly, a language used can activate the entire gamut of cultural scenario (Jared et al., 2013). This interesting co-activation has been reflected in studies showing how cultural context influence the way bilinguals process language, through cultural priming. In this regard, the concept of being bicultural is rather important. Bilinguals can not only be bicultural or bilingual but can also be bicultural bilinguals.

In the bilingual processing literature, the role of culture started getting attention in the last decade or so and Zhang et al., 2013 was among the first to investigate the role of visual context of heritage culture cue on cross-language interference through his study with Chinese-English speakers. Before this, much of the research on bilingualism was on the effects of linguistic context i.e., cross language interference (Marian et al., 2003; Bialystok et al., 2009; Poulisse, 1991) and culture was studied mostly by cultural psychologists.

### **Production Studies**

Heritage culture cues have been found to disrupt second language processing. For example, the influence of identity of interlocutor was examined in a series of studies by Zhang et al., 2013. In their study, Chinese-English participants listened to audio clips (study1) of a conversation partner who spoke on topics of campus-life in English. Participants were then asked to do the same on the same topics for 1 minute each in English. It was found that the presentation of a Chinese face disrupted the fluency English for the participants. In study 2, participants described the Chinese or American cultural icons for 1 minute each in English. Participants then completed a story-telling task making up a story about a culturally neutral image in the presence of the cultural icons. In this study also they found that Chinese face disrupted English fluency of the Chinese-English bilinguals. Exposure to iconic images of

Chinese culture hindered the fluency of English for the participants. These effects were further examined in recognition (study 3) task where the accessibility of Chinese lexical structures was tested in a recognition task using Chinese compound names that are not mirrored in English (e.g. literal meaning of pistachio in Chinese is ‘happy nut’). The results from this study indicated that the accessibility of Chinese lexical structure was increased for the Chinese-English bilinguals with exposure to culturally iconic images. And in study 4, an object naming task was conducted using the same cultural primes as in study 2 and 3. Naming performance in the second language (English) was reduced which may suggest that the Chinese cultural image disrupted language production in the second language. Thus, their studies found evidence of heritage-culture cues disrupting second language processing. A similar study on facial cues was conducted by Li et al., 2013 in which they investigated the role of nonlinguistic cues primarily face cues in modulating responses in a picture naming task. In their experimental design, they used faces from distinctive races (Asian vs Caucasian) and crossed them with the languages used for the picture naming (Chinese vs English). They found that when the face and the language matched, there was activation of the language in both L1 and L2 however, they could not find any disruption when there was a mismatch between the face and the language. They also found out that there was facilitation of English even in monolingual English speakers in the presence of Caucasian faces. Thus, their study found support for automatic priming and thus facilitation and activation from the socio-cultural identity of the face to the language needed for production. This study provided evidence for the effect of heritage culture cues through a priming mechanism.

Other studies have also shown that facial cues effect language production (Woumans et al., 2015; Liu et al., 2019). Interlocutor identity or face as a prime for language was investigated in a study by Woumans et al., 2015. In this study, Spanish-Catalan and Dutch-French bilinguals were initially introduced and made acquainted with certain faces and their corresponding language during simulated Skype conversations. Afterwards, they carried out a language production task, in which they generated words associated with the words produced by familiar and unfamiliar faces on screen. The participants word production was faster when they had to respond to familiar faces speaking the same language as previously in the Skype simulation, compared to the same face speaking the unexpected language. Besides, this language priming effect disappeared when it became clear that the interlocutor was actually a bilingual. This demonstrated that faces can prime a language, but their cueing effect disappears when it turns out that they are unreliable as language cue. The effect of faces on

bilingual language control was further examined by Liu et.al., 2019 using Asian and Caucasian faces. A language switching task was performed by non-proficient Chinese-English bilinguals in experiment 1 in which the participants had to name pictures in either Chinese or English. This was done in three contexts; baseline context in which no face was presented, congruent context in which the face and the language to be spoken matched and incongruent context in which the face and the language did not match. The same design was applied in experiment 2 with reduction of the cue presentation time. They found that in the first experiment, the participants exhibited symmetric switch cost in both baseline and incongruent context but asymmetric switch cost was observed in the congruent condition i.e., larger cost in L2 than L1. Thus, Asian face facilitated activation of the first language. But in experiment 2, asymmetric switch cost in the opposite direction was observed in the baseline context. These findings point towards the activation of lexical access of the two languages in the presence of socio-cultural facial cues. This study thus revealed different patterns of switch cost and dominance effects across conditions. Thus, in bilingual language control, contextual faces play a crucial role.

Bilinguals choose their language according to the identity of the interlocutor (Woumans et al., 2015; Zhang et al., 2015). The identity of the interlocutor can include faces, iconic cultural images etc, which are all part of culture. These visual cultural cues are salient triggers of languages and could modulate bilingual language use.

Not only faces but culturally biased or iconic images have also been shown to modulate bilingual language production. Studies have indicated that some representations of images are more strongly connected to one language than another. The assumption is that images from a certain culture should be activated more quickly in the language spoken in that culture (e.g., Chinese culture image and mandarin) than some other language. In this regard, Jared et al., 2013 reported a study using culturally-biased pictures in a picture naming study. In the study, Chinese-biased, Canadian/western-biased and neutral pictures were used. The Mandarin-English participants in their study were significantly faster in naming culturally-biased pictures in the culturally congruent language than in incongruent language. For a bilingual, this means that concepts can become culturally bound through experience. Thus, representation of culture and race like iconic images and faces seem to disrupt production in the non-target language (e.g., English) and seems to facilitate higher activation in the target language (e.g., Chinese). Roychoudhuri et al., 2016 examined if iconic pictures belonging to one's native culture intervenes with second language production in bilinguals in an object

naming task. Bengali-English participants named pictures in both L1 and L2 against iconic cultural images representing Bengali culture or neutral images. They named in both “Blocked” and “Mixed” language contexts. Participants were asked to name pictures in either English or Bengali according to the language context block. The iconic cultural images were presented on the background of the screen and the participants were asked to name objects as fast and accurately as possible. The participants faced interference in picture naming in L2 (English) in the presence of L1(Bengali) cultural image and Bengali cultural images also facilitated naming in L1. This was observed in both language context blocks. This suggests that native language culture cues tend to activate the L1 lexicon that competes against L2 words creating interference. These results provide support to the earlier studies where such culture related interference has been observed in bilingual language production experiments. Native culture cues induce higher activation of the L1 lexicon that interferes with the L2 production in bilinguals even when they are living in another culture and these effects are seen in bilinguals with good proficiency and dominance in their second language. This study examined the issue of native culture’s constraining effect during second language production in a group of highly proficient Bengali-English bilinguals in India using the picture naming task. The culture cues used in their study did not represent any speaker’s face and thus were not processed actively. Thus, their study was novel in the sense that even subtle presentation of visual cues in the background can affect language production. The study shows that different types of cultural cues might influence language selection differently depending on their salient values and importance. Their results show the modulatory influence of culture cues on language production, as well as high language proficiency in L2 does not lead to suppression of L1.

Cultural context can also affect switch cost (i.e., reactive language control) and reversed language dominance effect (i.e., proactive language control). Liu et.al., 2021 examined whether cultural context could influence reactive and proactive language control in bilinguals. Non-proficient Chinese-English bilinguals performed a language switching task in three contexts, i.e., baseline context, congruent context and incongruent context. Cultural biased image of Chinese and Western culture was used in a cued-language switching task. They found that when the culturally biased image matched the language for production, there was influence of cultural context on reactive language control. They also observed asymmetrical switch cost in congruent condition i.e., larger switch cost for L2 than for L1. The most likely explanation for this result is that for unbalanced bilinguals, the L1 with a

higher activation level is inhibited when speaking in L2 (Inhibitory Control model). So, when they have to switch from L2 to L1, L1 needs to be activated again, making it harder to access L1 words since it was inhibited earlier. Their results also pointed towards symmetric switch cost in the incongruent condition which means that the incongruent pictures did not affect the switch cost pattern. Thus, their study showed that culturally biased images affected reactive language control but not proactive language control as similar reversed language dominance effect across different cultural context was observed.

Overall, the literature indicates that cultural context either facilitates or inhibits language production in bilinguals. The cultural cues, though subtle, becomes salient indicators of language use in bilinguals and plays an important role in modulating language selection. The literature also indicates that the cultural context affects switch cost, i.e., reactive language control in bilinguals.

### **Comprehension Studies**

Research on the effects of culture cue in comprehension studies are sparse compared to production studies. But both production and comprehension are an integral part of language processing as discussed in chapter 1 and without comprehension there can be no production. The identity of the interlocutor, as a cue, affecting language comprehension even before the onset of linguistic signal was demonstrated by Martin et al., 2016. They examined the effect of interlocutor identity as a cue for language prediction with early proficient bilinguals using ERP paradigm. Before the experiment proper, the participants were first familiarized with the interlocutors who were either monolinguals or bilinguals. The task was an audio-visual lexical decision task (LDT) in which the participants had to decide if the utterance was a word or not. The results from the ERP analysis revealed that the participants' brain response to the interlocutor identity started even before the onset of speech. The participants also indicated different neural patterns when they were presented with monolingual interlocutors whose language could be predicted as opposed to bilingual interlocutors whose language could not be predicted. This suggests that listeners can rely on interlocutor identity as a cue for linguistic prediction during language processing even with no linguistic output and that proficient bilinguals process monolingual and bilingual interlocutors differently. This shows that linguistically or culturally biased contextual information significantly effect language processing. The cultural context also plays a crucial role in bilingual language activation and selection. Berkes et al., 2018 also found evidence for the effect of cultural context on selection process in a picture-word verification paradigm in two studies. The manipulation in

their studies was the picture which were culturally prototypical of Korean and North American and had both monolingual English participants as control group and Korean-English bilinguals as participants. The participants saw a picture and listened to a word simultaneously and were asked to decide if the picture and the word matched. In study 1, they found that bilinguals performed faster than monolinguals in culturally biased trials and the bilinguals' response was primed by culturally biased pictures in the congruent trials leading to faster response time. Monolingual participants also responded faster in the culturally congruent trials but they were also slower in incongruent trials which could be due to semantic match and cultural congruency and not cultural priming. They were also not familiar with the Korean culture. These factors created a conflict which the bilinguals were able to resolve but the monolinguals could not. In study 2, they manipulated the familiarity and did not find facilitation in the bilinguals as was with the cultural cues. In this study also monolinguals had a harder time with the mismatch familiarity. Their study points towards the influence of cultural context on bilingual language selection process.

Over the years, a number of comprehension studies have reported language switch cost across various types of tasks like lexical decision task, silent reading task and categorization tasks (Orfanidou & Summer, 2005; Thomas & Allport, 2000; Dussias, 2003; Declerck & Grainger, 2017). These findings were further reinforced by models like BIA+ model whose framework accounted for language switch cost. However, several behavioral and tracking studies have reported an absent switch (Von Studnitz & Green, 2002; Philipp & Huestegge, 2015; Olson, 2016). In addition to these, some studies reported an overlap between language control and domain general control (Declerck et al., 2017; Prior & Gollan, 2013) while others found no link between language switching and domain general cognitive control (Calabria et al., 2011; Cattaneo et al., 2015; Branzi et al., 2016; Liu et al., 2018).

Similar to the production studies, the literature on the influence of culture on bilingual language comprehension suggests that bilinguals rely on culture cues like interlocutor identity and culturally biased images during language processing.

### **Some New Studies with Mixed Results**

While these mounting evidences and researches are impressive, some studies have found mixed results with bicultural bilingual participants. For instance, Som et al., 2018 examined if iconic cultural images modulated lexical access during object naming. The participant in this study were 40 Bodo-Assamese bilinguals from Guwahati, India. The participants were

asked to name pictures which were preceded by the cultural images belonging to three types; congruent, incongruent and neutral. The experiment was divided into two sessions i.e., one naming in Bodo and the other was naming in Assamese. The results from the study suggested that the cultural images facilitated response in both the languages which means that the speakers were faster in naming when there was a match between the cultural image and the language used for naming. However, they did not find any evidence of response inhibition in the response analysis as there was no significant delay in response when there was a mismatch between the cultural image and the language used for naming. This study was novel in the sense that the participants were bicultural bilinguals living in a mixed language context and residing within their native culture. Most participants in previous researches were immigrants living in their L2 dominant environment far from their native culture (Jared et al., 2013; Zhang et al., 2013; Roychoudhuri et al., 2016). Therefore, for such bilinguals the L2 and the culture of the L2 becomes more dominant as they get less opportunity to use their L1 and witness their native culture. This study brings up a crucial gap in the literature, i.e., the lack of research on non-immigrant bilinguals from non-WEIRD countries and highlights the importance of bilingual context.

These findings suggest that bilinguals are very sensitive to visual cues which helps them in language control. It has been established that there is parallel activation of language in bilinguals (Jared & Kroll, 2001; Hoshino & Kroll, 2008; Costa & Sebastian-Galles, 2014) even in contexts in which only one language is required. So how is the target language selected by bilinguals and how are they able to suppress interference by the target language? These visual cultural cues might be modulating bilinguals' language selection in language comprehension and production. Additionally, meaning of a word is closely associated with culture-specific knowledge (Dong et al., 2005; Gollan et al., 2008; Pavlenko, 2009; Declerck & Phillip, 2015a) and this association between meaning and cultural knowledge might be a contributing factor in language selection process, making lexical access easier through the culture. Furthermore, the cultural context seems to effect switch cost i.e., reactive language control in bilingual language processing. Overall, the cultural context of a bilingual seems to have an influence on bilingual language control and processing. The evidences from the literature also suggests that cultural factor might impact the activation and inhibition of the target language thus influencing the language selection process. But it is not clear as to what extent this non-linguistic factor, i.e., the cultural context modulates language control in bilinguals and if it is the same for all bilingual populations.

## 2.4. Linguistic Context

Distinct and unique bilingual experiences modulate language use. A bilingual speaker processes two or more language at a time avoiding activation and interference from the non-target language. This ability is called language control and can happen while speaking, reading, listening and writing. This control in turn confers cognitive advantages (Carlson et al., 2008; Bialystok et al., 2011) and such an advantage was not seen in monolingual speakers.

### **Bilingualism and Language Control:**

Language control studies to date has mostly focussed on language production and not much on word recognition. The Inhibitory Control (Green 1986, 1993, 1998) has been used to investigate language control in production, language recognition studies have relied on the Bilingual Interactive Activation (BIA) (Grainger & Dijkstra, 1992). Studies on bilingual language control in production have shown evidence for asymmetrical switching cost i.e., dominance related inhibition i.e., larger switching costs for the stronger than for the weaker language (Meuter & Allport, 1999; Jackson et al., 2001; Macizo et al., 2012; Bobb & Wodniecka, 2013; Peeters et al., 2014; Fink & Goldrick, 2015; Reynolds et al., 2016). Symmetrical switching cost has also been found when the dominance difference between the two language is relatively small (Christoffels et al., 2007; Schwieter & Sunderman, 2008; Declerck et al., 2013; Fink & Goldrick, 2015).

However, there are fewer studies investigating language control in recognition (von Studnitz & Green, 1997; Thomas & Allport, 2000; Orfanidou & Sumner, 2005; von Studnitz & Green, 2002; Macizo et al., 2012). Similar results on symmetrical switching cost have been found in these studies. The flexibility of language switching is unique to bilinguals.

### **Bilingualism and Executive control:**

One of the most reported advantages of bilingual language switching practices is improvement and enhancement of executive control. There are various studies reporting better performance by bilinguals as compared to monolinguals in executive control task (Bialystok et al., 2004; Bialystok et al., 2008; Costa et al., 2008).

However, the benefits of bilingualism on task switching have been inconsistent. Although some studies have found evidence of bilingual advantage in switching paradigm studies (Prior & MacWhinney, 2010; Gold et al., 2013; Wiseheart et al., 2014) recent studies to

replicate this have found no effect (Hernandez et al., 2013; Paap & Greenberg, 2013; Paap & Sawi, 2014). Therefore, the interaction between language control and cognitive control is not clear. The findings from these studies suggests that the bilingual advantage may not be from bilingualism itself but may depend on the type of bilingualism and language switching practises might be crucial for cognitive control advantages. Thus, there is a need for concrete evidence on the role of bilingual interactional context and language switching practises in studies on the bilingual advantage in task switching and cognitive control.

The Adaptive Control Hypothesis (ACH) by Green & Abutalebi (2013) discussed the relationship between language switching and cognitive control. The hypothesis describes three interactional contexts: Single Language Context (SLC), Dual Language Contexts (DLC) and dense code-switching context. According to the hypothesis, cognitive control differs according to the language control demands placed during the interactional context. In a non-verbal task-switching paradigm, Hartanto & Yang (2016) examined the theoretical predictions of ACH by comparing young adult bilinguals belonging to the SLC and DLC. As theorised by the ACH, they examined if there was a difference in switch cost between the DLC and SLC. The participants in this study were from Singapore and they performed the colour- shape switching task. In this task, the participants were asked to respond either to the colour (red or green) or shape (triangle or circle) of a target. The results indicated that the DLC participants had significantly faster RTs in the switch trials as compared to the SLC participants suggesting smaller switch cost and efficiency for the DLC participants. The results from this study provided evidence for ACH suggesting that the context of the bilinguals modulates language control and in turn cognitive control. These findings were further supported in another study by Hartanto & Yang, 2020. In this study, 175 bilinguals from a local university in Singapore took part in 9 executive function task like flanker and colour-shape switching task. They found that DLC participants were better at task switching than SLC participants. This finding is in line with the ACH because dual language context would place stronger demand on task switching than single language context and dense code-switching context and thus adaptively enhance DLC bilinguals' task switching abilities. A notable finding of the study was that the SLC participants and DLC participants did not perform any better than dense code-switching participants in terms of inhibitory control and goal maintenance abilities which is contrary to the predictions of the ACH. In fact, the dense code-switching bilinguals were significantly better than the SLC bilinguals in inhibitory control and goal maintenance. This finding suggests that over time bilinguals in dense code-

switching context may adaptively evolve and enhance these executive functions. As they did not find any interaction between interactional context and working memory task, they suggest that the impact of interactional context on executive function may be specific to certain areas like inhibitory control, task switching and goal maintenance. Overall, their study was very robust and demonstrates that the interactional context of the bilinguals modulates bilingual advantages in executive function.

Henrard & van Daele (2017) found support for the hypothesis in a study where 60 translators, 60 interpreters and 60 monolinguals performed five computerised tasks (Reaction time task, letter memory task, anti-saccade task, plus-minus task, Brown-Peterson task) in random order. The interpreters and translators were bilinguals who used two to three languages every day at work and faced dual-language environment as compared to the monolinguals. Their results showed that efficiency in cognitive flexibility and inhibition were demonstrated more by the interpreters and the translators as compared to the monolinguals. Verreyt et al., 2015 also found evidence for the influence of language-switching experience on the bilingual executive control advantage. The aim of the study was to see the influence of language switching experience on executive control. In their study, Dutch-French bilinguals took part in a Flanker task and Simon Task. The participants belonged to balanced bilinguals who frequently switched languages, balanced bilinguals who do not switch languages and unbalanced bilinguals. The results from both the tasks showed smaller congruency effect for bilinguals who often switch between languages than bilinguals who do not, even though these bilinguals were also high proficient in their L2. Their study shows that better performance in tasks is found only in bilinguals who regularly switch between languages. Executive control advantage will be seen only when the lexical representation of both languages is constantly activated and inhibited simultaneously during frequent language switching with greater demand for monitoring. Thus, they argue that for the development of a stronger executive control system, language switching plays a crucial role. Ng & Yang, 2021 examined the influence of bilingual code-switching pattern on three control processes drawn from the ACH; interference control, salient cue detection and opportunistic planning. The participants in their first study were forty Chinese English-bilinguals from a local university. The participants performed a verbal opportunistic task where participants were asked to complete sentences that best fit the context in any language with the most appropriate answer and as quickly as possible. The sentences were constructed in such a way that only by seizing the opportunity to code-switch, the participants would be able to give the most appropriate

answer. In their second study, one hundred and fifty undergraduates who performed a verbal opportunistic task and an Attention Network Task for Interaction and Vigilance (ANTI-V) to measure interference control and salient cue detection. The results from the opportunistic planning task were in line with the ACH since participants were able to flexibly adapt to the alternative expressions from one language to another. However, the participants did not exhibit any advantage in interference control and salient cue detection. They postulate that this could be due to the possibility that dense-code switching happens in communities where multiple languages are valued and commonly used. Thus, sensitivity to changes in salient linguistic and contextual cues are deemed unimportant. Thus, the findings from their study lend a partial support to the ACH.

Another crucial evidence for interactional context modulating cognitive control was reported by Beatty-Martinez et al., 2019. The aim of this study was to examine the three bilingual interactional contexts as proposed in the ACH and their association to cognitive control. Three groups of Spanish-English bilinguals belonging to the three interactional context who differed in their language switching patterns in their everyday life took part in the experiment. The participants in this study performed two picture naming task and the “AX” variant of the Continuous Performance Task (AX-CPT) which is a non-linguistic measure for cognitive control. Their results showed that the association between lexical access and cognitive control ability depended on the interactional context of the bilinguals. Wu & Thierry, 2013 also reported on the modulating effect on executive functions by the language context of bilinguals. In their study, the participants belonged to a single group of Welsh-English speakers. The participants performed a Flanker task in which they were instructed to indicate the direction of the central arrow. Words were used occasionally instead of the arrows which the participants were told to ignore. The experiment was divided into three blocks, monolingual blocks in which all the words were in Welsh or English and a mixed block where the words were equally divided between Welsh and English. The results analysis of both reaction time and ERP showed that the mixed language context facilitated non-linguistic conflict resolution. This enhancement of executive function was observed only in incongruent trials in the mixed block as compared to the monolingual blocks. This suggests that the language context of the bilinguals helps in inhibiting irrelevant information during conflict resolution. Thus, by manipulating the language context, the study showed that the bilinguals long term experience of juggling two languages modulated cognitive control.

The evidence for the impact of interactional context of bilinguals on attentional control have also been reported from comparative studies between monolinguals, non-switching bilinguals and switching bilinguals (Ooi et al., 2018). The participants in this study were monolinguals and early and late non-switching bilinguals from University of Edinburgh and switching bilinguals from the National University of Singapore. The participants performed an ANT task and the TEA Elevator task. Their results showed that there was a difference between the monolinguals and bilinguals and also between the bilinguals as well. The Singapore bilinguals performed better than the monolinguals and Edinburgh late bilinguals in conflict monitoring. The participants who were involved in language switching were more efficient in conflict resolution which is again consistent with the prediction of the ACH.

Similar report on the modulating effect of interactional context was reported by Yang et al., 2016. The participants in this study were thirty Cantonese-Mandarin-English trilingual speakers who were highly proficient in Cantonese and Mandarin and moderately proficient in English. In this study, the participants performed a picture naming task, followed by a Flanker task. The picture naming task was in three dual languages contexts; L1-L2, L2-L3, L1-L3 contexts. In the picture naming task, participants named pictures in alternate two languages. The study also explored the neural correlates and functional brain networks through fMRI. Their results showed that the flanker effect was seen only in the L2-L3 and L1-L3 context and not in L1-L2 context. In the behavioural analysis, the effect of contextual priming was not observed in reaction time and there was insignificant activation of brain regions for inhibitory control in L1-L2 context. Whereas, in L2-L3 and L1-L3, flanker effect was seen in both reaction time and brain activation from the neuroimaging analysis. This pattern of activation was found in areas dedicated to inhibitory control areas like the right inferior frontal gyrus, bilateral insula, left Rolandic operculum, bilateral supramarginal gyrus, and right thalamus (Mechelli et al., 2004; Green et al., 2006; Shomstein & Yantis, 2006). Thus, the findings from their study suggests that bilingual interactional context modulate language control processes by adaptive changes in the neural regions associated with control processes and provides empirical evidence for the ACH.

Contrasting evidence to these studies have also been found in other studies. Hofweber et al., 2016 conducted a frequency judgement task with two groups of German-English bilinguals who differed in their dense code-switching behaviour. The participants were asked to imagine a conversational situation with a bilingual friend and to rate the frequency of code-switching utterance they might encounter. The study found that bilinguals with reported higher dense

code-switching engagement demonstrated inhibitory control advantages in high conflict monitoring conditions in Flanker task. High frequency of code-switching was positively associated with non-verbal conflict monitoring by the correlation analyses. They argue that code-switching among the bilingual population is a natural type of language production since no evidence for cognitive monitoring efficiency was found in their study. A similar kind of observation was reported by Lai & O'Brien, 2020. They examined the effect of language switching and cognitive control through the assumptions and predictions of the Adaptive control hypothesis in a series of tasks involving verbal fluency task, word switching task, sentential task, naturalistic conversation task, verbal Stroop task and a non-verbal Global-Local task. Their participants were English-Mandarin bilinguals from Singapore and had reported frequent use of both the languages. One of the aims of the study was to examine the ACH assumption that there are three interactional contexts of a bilingual. They observed that all the bilinguals reported regular exposure to both L1 and L2 to varying degrees. The distinction between the interactional context as proposed in the ACH might not be clear in multilingual societies. In such societies, the bilinguals may engage fluidly in all contexts to varying degrees. This finding further highlights the notion and current views that bilingualism is dynamic and not categorical. The results from their study also did not find any association with the language switching environment and language control. Thus, their findings suggest that there might be other factors influencing how bilinguals switch their languages in their immediate linguistic environment. Further investigations of the predictions of the ACH on a large-scale correlational study by Kałamała et al., 2020 did not find any interaction between the demands of the dual language context experience and the efficiency of response inhibition in a group of 215 Polish-English bilinguals from Poland who used two languages on a daily basis. The aim of their study was to see if the claim of ACH that bilingualism enhances the cognitive processes that are actively used by bilinguals. They used a series of classic tasks in this experiment to measure the response inhibition like the anti-saccade task, the go/no-go task, the Stroop task and the stop-signal task. These tasks have been shown as a measure for response-inhibition construct from previous studies (Friedman & Miyake, 2004; Miyake et al., 2000). The results from their study did not find reveal any association between the efficiency in response inhibition tasks and the intensity of DLC experience. Even though the tasks used were reliable, the findings from their study were in contrast to the predictions of ACH that bilinguals who experience DLC environment do not engage response inhibition to control language production. Thus, the null relationship between the DLC experience intensity and response inhibition suggests that DLC bilinguals

either do not engage response inhibition during language use or use it to the same extent as SLC and dense code-switching context bilinguals. Thus, the results from this study do not support the predictions of the ACH at least at the behavioural level.

Despite ACH being a very recent theoretical framework, many studies have found evidence in support of the predictions in ACH. The main proposal being that the intensity of demands placed by the linguistic environment would modulate adaptive changes enhancing executive which in turn would modulate executive function like response inhibition, switching efficiency, conflict monitoring etc. However, it is still debated as to how and to what extent this modulating effect can be seen. Some researchers (Lai & O'Brien, 2020) are of the opinion that the divisions of the three types of bilinguals according to ACH in itself might not be clear as in many multilingual societies, bilinguals might be engaging in all three language contexts to some extent. Therefore, they argue that bilingualism cannot be categorised and must be looked at in a more fluid way and at other factors that might be influencing bilingual language switching.

## **2.5. Gaps in Literature**

One of the crucial gaps in the literature of the role of cultural factors and linguistic context is the lack of research from multilingual and multicultural communities. As pointed out by Lai & O'Brien, 2020, the distinct type of bilingual experiences plays a crucial role in bilingual language processing. Bilingualism in itself is dynamic and complex and the distinct range of experiences may modulate adaptation in neural and cognitive processes (Luk & Bialystok, 2013; Bak, 2016). The fluid nature in which interaction happens in multicultural and multilingual societies might render the subtle cues like cultural images unimportant. Thus, for bilinguals in such communities, the effect of culture might not be seen. Same thing goes for switching behaviour which becomes a common phenomenon in the multilingual world. The literature so far on the role of culture and linguistic environment does point towards the importance of bilinguals' immediate environmental context which could modulate language processing and different domains of executive control processes. However, more representation from multilingual communities with distinct cultural practices and a nuanced social set up is required to fill in these gaps in our understanding.

## 2.6. Chapter Summary

This chapter provided a critical examination and overview of the existing literature on the role of culture and linguistic environments on bilingual language processing. In summary, research on the role of cultural factors on bilingual language processing suggests strong influence on the activation and inhibition of language impacting the language selection and recognition processes. Moreover, the literature also suggests strong association between word meaning and culture as salient culture cues seem to activate corresponding languages and aid in switching effect. The review of literature on the role of linguistic context brings up a major and highly debated issue, i.e., the modulating effect of language control on cognitive control processes. The literature points towards strong evidence in support of ACH which states that the intensity of demands placed by the interactional context would modulate control processes differently.

To sum up, despite numerous and extensive research in these areas, it is still not clear as to how these factors influence bilingual language processing as there have been many conflicting reports.

## CHAPTER 3: METHODOLOGY



### **3.1. Introduction**

Research in language relies on observational as well as experimental methods. Observational research involves observing naturalistic human behaviour and is also known as descriptive research. On the other hand, experimental methods in linguistics involves presenting participants with instructions and stimuli with the aim of examining a cognitive factor and monitoring the response of the participants. These experiments links theories to tangible data in a systematic and coherent way by controlling the variables and testing hypothesis. Various techniques are used for presenting of stimuli and collecting of data. Data collection can involve various techniques like recording response time through a computer, recording brain activity etc. Response data can be recorded even to the minute milliseconds which is one of the advantages of experimental methods.

One way to understand cognitive, linguistic and behavioural aspect of bilingualism is to design an experiment with changing variables and look at how these variables influence behavioural and cognitive performances. This type of research is known as experimental research, enabling greater control over the targeted behavioural and cognitive processes by manipulating and controlling the variables like the length of the words in both languages.

Standard experimental methods were adopted for the current study, keeping in mind the aims and objectives of the research.

### **3.2. Chapter Overview**

This chapter provides details of the various methods used in the course of this study which includes questionnaires, designing of experiments, procedures of data collection and analysis of the data.

The current study is based on experimental methods. Each experiment set has its own stimuli set, participants and questionnaires. The role of questionnaires was to get the relevant background information of the participants for that experiment. There were a total of eight experiments, four on the role of cultural context and four on linguistic context. Table 3.1 provides a brief description of the studies, participants and tasks.

*Table 3.1. Brief Description of Experiments, Participants and Tasks*

<b>Experiment (Chapter)</b>	<b>Participants</b>	<b>Task</b>
Experiment 1 (Chapter 4)	Rongmei-Meitei bilinguals	Translation word recognition task Effect of culture cue
Experiment 2 (Chapter 4)	Ao-Sangtam & Sangtam-Ao bilinguals	Translation word recognition task Effect of culture cue
Experiment 3 (Chapter 4)	Ao- Sangtam & Sangtam-Ao bilinguals	Flanker task Response inhibition
Experiment 4 (Chapter 4)	Ao-English bilinguals	Lexical Decision task Effect of culture cue
Experiment 5 (Chapter 5)	Ao-English DLC and SLC bilinguals	Lexical Decision Task Effect of interactional context
Experiment 6 (Chapter 5)	Ao-English DLC and SLC bilinguals	Attentional network Task Executive functions
Experiment 7 (Chapter 5)	Ao-English DLC and SLC bilinguals	Simon Task Conflict monitoring
Experiment 8 (Chapter 5)	Ao-English DLC and SLC bilinguals	Audio-visual recognition task Effects of context

### 3.3. Questionnaires

Even though the thesis is dependent on experimental studies and their results, questionnaires were also used for each of the experiment set. These questionnaires are part of the pre-processing for the studies. They serve the purpose of collecting the background information of the participants on various grounds, in keeping with the main question addressed in the relevant experiment. A number of such questionnaires were thus used. Below, these are discussed in detail.

- a. To collect the background information of the participants' language history a standardized language history questionnaire and Language Experience and Proficiency Questionnaire (LEAP-Q, Blumenfeld & Kaushanskaya, 2007, 2020) was used. In these questionnaires, self-assessment based measures relating to age of acquisition (AoA), proficiency and everyday usage in various domains like home, educational institutions etc., for both languages were collected (see appendix A & B).
- b. Lextale test (Lemhofer & Broersma, 2012) was used to test the English proficiency of the participants in experiments 4, 5, 6, 7 & 8. It is a test of vocabulary knowledge for medium to high proficient speakers of English. The test takes about 3.5 minutes on

average to complete as it comprises of only 60 trials which makes it a practical and feasible measure. The test can be administered online or implemented and downloaded in other softwares like Praat, Presentation and Matlab formats. A similar test was adapted to measure Nagamese proficiency of participants in experiment 8.

- c. To determine the participants' interactional context, a revised version of the Bilingual Interactional Context Questionnaire (Hartanto & Yang, 2016) was used. As identified by ACH, the participants were asked to give self-report on the prevalence of the three-interactional context across four different situations, i.e., home, educational institutions/work, social interactions & non-social interactions. Participants used percentage (total 100 for each context) to report whether their conversational exchanges resembled SLC, DLC or dense code-switching context in each of the situations. Formula (see appendix C) for the three language indices as given in the Bilingual Interactional Context Questionnaire was used to determine the prevalence of the participants interactional context.

### **3.4. Participants and Field Area**

The participants belonged to different bilingual communities for each of the experiments. In order to factor in the different types of social interaction patterns, connect to one's own culture, type of second language spoken etc., participants for the eight experiments were chosen from different geographical areas. Primary focus area for all the experiments was the state of Nagaland and different Naga groups spread across North East India as well as the rest of the country. Along with Nagaland, other states that were relevant for the study are Manipur and Assam, primarily because the Naga groups under study reside in these places. Below we discuss the bilingual groups and their geographical distribution in detail.

- a. The participants in experiment 1 were from Tamenglong, Manipur and Guwahati, Assam.
- b. In experiment 2 and 3, the participants were from Longkhim, Nagaland.
- c. The participants in experiment 4 were Naga university students from different universities across India, like Delhi University, University of Hyderabad, Guwahati University, Jawahar Lal Nehru University etc.

- d. The participants in experiment 5, 6 and 7 were from Dimapur, Nagaland and belonged to Ao-Naga speaking community.
- e. The participants in experiment 8 were university students belonging to various Naga tribes and from different universities across India.

All the participants were recruited through consultation emphasizing the need for L1 native speakers for each bilingual group. A total of 225 participants (54 Rongmei-Meitei bilinguals, 40 Ao-Sangtam bilinguals, 40 Sangtam-Ao bilinguals, 61 Ao-English bilinguals and 30 Nagamese-English bilinguals) took part in the study. Table 3.2 gives the detailed distribution of participants across experiments. Figure 3.1 highlights the main areas of origin of the participants of the experiments.

*Table 3.2. Distribution of Participants Across Experiments*

<b>Experiments</b>	<b>Participants</b>
Exp 1	27 older Rongmei-Meitei bilinguals 27 younger Rongmei-Meitei bilinguals
Exp 2	40 Ao-Sangtam bilinguals 40 Sangtam-Ao bilinguals
Exp 3	Same participants as experiment 2
Exp 4	20 Ao-English bilinguals
Exp 5	20 Ao-English SLC bilinguals 21 Ao-English DLC bilinguals
Exp 6	Same participants as experiment 5
Exp 7	Same participants as experiment 5 & 6
Exp 8	30 Ao-English bilinguals

Figure 3.1 shows a map of the field area.



*Figure 3.1. Geographical distribution of the participants.*

### **3.5. Tools**

The experiments were designed using the software E-prime, version 2 and 3 (Psychology Software Tools) on windows 10. E-Prime is the most comprehensible tool available for behavioural research and can be used for computerised experiment design, data collection and analysis. It gives precise timings in milliseconds to ensure data accuracy. The presentation of data was done using a desktop and HP laptop with a 14.5-inch viewing screen. The participants were seated at a distance of about 60cms from the computer screen. The experiments were carried out in quiet and distraction free environments where the participants sat in front of the computer screen where the experiment was displayed. For experiments 4 and 8, the data was collected (during COVID lockdown) remotely using E-prime Go (Psychology Software Tools, 2020). E-Prime Go lets the experimenter host the experiment on the E-Prime Go site and share the link with the participants. The participants were instructed to download the experiment through the link and run the experiment on their own computers. Once the participant completes the experiment, their data automatically gets uploaded to the account of the experimenter. For all the experiments, the keyboard of the computer was used as the response medium where keys were assigned for the response (e.g. '1' for 'YES' or '2' for 'NO').

### **3.6. General Procedure**

All the participants were tested individually and in a quiet and distraction free environment. The experimenter gave verbal instruction to each participant before the start of the experiment. For the experiments where E-Prime Go was used, the participants were instructed to run the experiment in a distraction free environment.

### **3.7. Tasks or Experiments**

How a stimulus is perceived depends on the context in which it is presented. According to Kornblum & Lee, 1995, these context effects include Simon task (Simon, 1969), Stroop task (Stroop, 1935), Flanker task (Eriksen & Eriksen, 1974), priming task (Scarborough, Cortese & Scarborough, 1977) etc. In these tasks, a stimulus consists of a target attribute to which the participants are required to respond to and a task irrelevant attribute which affects the response latency. For example, in a Stroop task, the colour of the word is the target attribute and the colour of the ink in which the word is written is the irrelevant attribute. In such tasks, the experimenter can manipulate the attributes of the stimulus to either facilitate or create conflict in response. This can either lead to either congruency between the stimulus and the target or incongruency. The congruency effect can lead to relative faster response time (RT) in congruent trials as compared to incongruent trials. This congruency effect can be due to various reasons like spreading activation (Neely, 1991), selective attention (Spieler, Balota & Faust, 2000), response inhibition (Ridderinkhof, 1997) and cognitive control (Botvinick et al., 2001).

In our experiments, we used two types of linguistic tasks; translation equivalent recognition task and lexical decision task and three non-linguistic tasks; Simon task, Flanker task and Attentional Network Task (ANT).

Each of these experimental paradigms are discussed below.

#### **3.7.1. Simon Task**

Simon task (Simon & Wolf, 1963) is one of the well-established experimental paradigm designed to study the stimulus-response compatibility (SRC). This task is designed to study the effects of irrelevant cues. In this task, participants have to respond according to a non-spatial feature of the target stimulus (e.g., colour) while ignoring an irrelevant one (e.g.,

position on the screen). The combination of the two dimensions leads to congruent and incongruent trials. For example, participants may be told to press the right response key if a blue square appears and the left response key if a green square appears. These stimuli are presented on the left or right sides of the screen so that position information becomes part of the stimulus display although it is not relevant to response selection. In congruent items, the irrelevant spatial position supports the rule-directed correct response (e.g., blue square on right side); in incongruent items, the irrelevant spatial position conflicts with the correct response (e.g., blue square on left side). The task, therefore, requires inhibitory control to ignore the irrelevant position information in the incongruent trials. Even though the spatial position in which the stimulus is irrelevant, responses tend to be slower for incongruent than for congruent trials (the Simon effect), an effect that reveals the cost associated with resolving the incompatible information given by the two dimensions. This effect occurs due to the conflict between the stimulus and response. Bialystok (2004, 2005, 2006) has consistently found that bilingual participants tend to be overall faster than monolinguals in tasks that involve inhibitory control such as the Simon task. It was also found that reaction times were faster in the congruent condition compared to incongruent condition. Simon congruency effect is seen in older bilinguals than age matched monolinguals (Bialystok et al, 2005, 2007, 2008). While others report no significant difference in RTs (Reaction Times) and accuracy (Guido-Mendes, 2015; Linck, Hoshino & Kroll, 2008; Paap & Greenberg, 2013) and no interaction between group and congruency conditions, even when controlling the bilingual group for native speakers, second language (L2) spoken, and immigration status (Paap & Greenberg, 2013). This effect has been unreliable in children (Bialystok et al., 2004; Martin-Rhee & Bialystok, 2008) and young adults (Costa et al., 2009). The competition at the response selection stage in the Simon task results from the automatic coding of the position of the stimulus which in turn activates the spatially corresponding response. Some studies have also found no correlation between the Simon effect and language switch cost (Jylkka et al., 2018; Struys et al., 2019).

### **3.7.2. Flanker Task**

Flanker task (Eriksen & Eriksen, 1974) is used to assess visual processing and attention in a particular task. In this task, participants are asked to indicate whether a central arrow (>) points to the right or left. This arrow is presented along with flanker arrows pointing to the same direction (congruent trials >>>>>) or different direction (incongruent trials <<<<<) than the target arrow. The participants have to indicate the direction of the target arrow or

stimulus while ignoring the irrelevant flankers. The difference in the performance for congruent and incongruent trials is used to assess the degree to which the flankers can be ignored or filtered. This is known as the flanker congruency effect. Usually, responses tend to be faster and more accurate to congruent stimuli as compared to incongruent stimuli. The difference in RT and error rates are used to measure the efficiency of selective attention. The Flanker effect is much like the Simon effect in that both measures the ability to suppress irrelevant information through the difference in RTs between congruent and incongruent conditions. The Flanker effect has been replicated in various visual stimuli like colour (Servant et al., 2014), arrows (Ridderinkhof et al., 1995) etc. These studies (Eriksen et al., 1986; Evans et al., 1992; Richardson et al., 2011; Ridderinkhof et al., 2005; Rueda et al., 2004; Cragg, 2016) have contributed to research and investigations in both cognitive, developmental and clinical psychology. This is also used extensively in bilingual research, specifically in bilingual advantage research reporting faster reaction time for bilinguals in both congruent and incongruent trials (Costa et al., 2008; Carlson & Meltzoff, 2008; Costa et al., 2009). However, some studies have also reported no congruency effect or bilingual advantage (Emmorey et al., 2009; Prior & MacWhinney, 2010; Kousaie & Phillips, 2012a; Humphrey and Valian, 2012). While other studies reported no overlap and relation between language control and executive control (Grainger et al., 2010; Declerck et al., 2019).

### **3.7.3. Lexical Decision Task (LDT)**

Lexical Decision Task (LDT) is the most widely used experimental paradigm in visual word recognition studies. In an LDT, participants are presented with strings of letters on the screen and are asked to decide as fast and accurately as possible if the string of letters are words in the target language (e.g., Red or Ced) by pressing an assigned key on the keyboard. Stimuli can either be written and presented on a computer screen (visual) or played over headphones (auditory). The time it takes for the participants to respond, i.e., the response latency or reaction time as well as the accuracy of the response gives information about the processing cost or lexical access. Typically, in LDT, the stimuli consist of 50% real words and 50% non-words. The rationale behind the task is that participants should be faster at recognising the real word than the non-word. Therefore, the mental accessibility of a word is reflected in the response latency. The accessibility of the words can also be facilitated by a previous context known as priming, which is the automatic spread of activation or processing between related meanings or forms in the mental lexicon. LDT is used for analysis of lexical items and to

evaluate lexical access and formation. At first, the performance in LDT was thought to be a pure measure of lexical access i.e., the time needed by each individual word representation for activation in the mental lexicon. Later it was found that the RT was also affected by a number of factors like the similarity of the stimuli to the other words of the language (Grainger & Jacobs, 1996) and between the word and non-word (Keuleers & Brysbaert, 2011). One of the most common phenomena observed in this field is the cognate facilitation effect, i.e., bilinguals process cognates (words with identical form and meaning) faster than non-cognates (words that exists only in one language) (de Groot & Nas, 1991; Dijkstra et al., 1999; van Hell & Dijkstra, 2002; Lemhofer & Dijkstra, 2004; Lemhofer et al., 2008; Peeters et al., 2013; Cosmena et al., 2015; Poort, Warren & Rodd, 2016; Poort & Rodd, 2017). Cognate facilitation was observed even in tasks that did not require a decision from the participants like eye tracking (Duyck et al., 2007; Libben & Titone, 2009; van Assche et al., 2011). While the research on this effect is quite robust, another effect in bilingual visual word recognition known as interlingual homographs inhibition effect paints a more nuanced picture. Interlingual homographs are words with same form in more than one language but differ in meaning. This effect also provides evidence (Dijkstra et al., 1998; Von Studnitz & Green, 2002; Lemhofer & Dijkstra, 2004; van Heuven et al., 2008; Lagrou et al., 2011) for non-selective lexical access and integrated lexicon in bilinguals.

#### **3.7.4. Translation Equivalent (TE) Recognition Task**

The translation equivalent recognition task is used as an experimental paradigm to investigate the status of L1 translation equivalent in L2 processing and the effect of L2 proficiency level. In translation equivalent word recognition task, participants are presented with word pairs and are asked to decide if the word pairs are a translation equivalent pair or not. The words in the pair will be from two different languages and they can be presented either simultaneously or sequentially. In the task, half of the word pairs are real translation equivalents and the other half are not. The role of meaning and L1 translation in L2 lexical processing can be examined by manipulating the relation between the non-translation word pairs. Studies have also shown that there is faster reaction time in backward translation, i.e., from L2 to L1 than forward translation, i.e., from L1-L2 (Kroll & Stewart, 1994; Sholl et al., 1995; Choi, 2005; Bowers & Kennison, 2011). On the other hand, several studies have also reported the opposite as well as null effects (de Groot et al., 1994; van Hell & de Groot, 1998; Christoffels et al., 2003; Duyck & Brybaert, 2008). Other factors like semantic categories (de Groot 1992;

van Hell & de Groot, 1998a) and cognates (Costa et al., 2000; Christoffel et al., 2004; Dijkstra et al., 2010) can modulate the translation directionality effect. In these studies, words belonging to the same semantic categories were recognised faster and cognates (orthographic and phonological similarities between translation equivalents) were processed faster than non-cognates resulting in cognate facilitation even for words with partial similarity. Thus, cognates were translated faster than non-cognates in both language directions. Thus, translation recognition performance is sensitive to directionality (backward and forward) and lexical access is modulated by the semantic category as well as cognate status. The proficiency of the bilinguals also plays a crucial role in the priming effect. It has been found that asymmetry more in unbalanced bilinguals with lower level of proficiency (Gollan et al., 1997; Jiang, 1999; Duyck & Warlop, 2009; Nakayama et al., 2016; Lee, Jang & Choi, 2018) whereas for balanced bilinguals, the asymmetry is less (Perea et al., 2008; Dunabeitia et al., 2010).

### **3.7.5. Attentional Network Task (ANT)**

The Attentional Network Task (ANT) (Fan et al., 2002) is a combination of cue reaction time task (Posner, 1980) and a Flanker task (Eriksen & Eriksen, 1974). This task is used widely for assessing various issues from genetic studies of attention (Fan et al., 2003; Fossella et al., 2002) to developmental studies of attention (Rueda et al., 2004). In this task, participants are asked to decide or indicate if a central arrow (  $\rightarrow$  ) points to the right or left. This central arrow is flanked on both side by arrows pointing in the same direction (congruent trials  $\rightarrow\rightarrow\rightarrow\rightarrow\rightarrow$ ) or opposite direction (incongruent trials  $\leftarrow\leftarrow\rightarrow\leftarrow\leftarrow$ ). The time needed to resolve the conflict between the target stimulus and the flankers leads to slower reaction times for incongruent conditions as compared to congruent conditions. To explore the functioning of the executive control, this conflict effect is used. By presenting a cue before the target stimulus, the functioning of the alerting network is studied. Presentation of the cue leads to faster response time as compared to no cue presentation. Lastly, by presenting a cue that signals where the target stimulus will appear on the computer screen, the orienting network is explored. When the cue gives spatial information of the target, responses tend to be faster as compared to when it does not give any information regarding the position of the target. This task is used to assess the functioning of conflict monitoring and inhibitory control. In bilingualism literature, ANT is used to explore the impact of bilingualism on the

attentional abilities of bilinguals. The hypothesis that the continuous use of control mechanisms by bilinguals affects positively the development of the executive control network, and in particular of the inhibitory control component, leads to a clear prediction: the difference between congruent and incongruent trials will be larger for monolinguals than for bilinguals. That is, bilingualism would aid conflict resolution. Bilingualism was found to have a positive effect on the achievement of more efficient functioning of two attentional networks: the alerting network and the executive control network (Costa et al., 2008). Bilinguals also showed significant advantage in conflict monitoring as compared to monolinguals in the ANT (Pelham & Abrams, 2014). However, some studies have shown that the bilingual advantage may be present only in adults due to lifelong bilingualism (Anton et al., 2015) as no difference was found between bilingual and monolingual children in ANT. Statistically significant differences was also not found in the interference effect between the groups, nor was there a bilingual advantage in any of the three attentional networks (Rodrigues & Zimmer, 2016). Thus, variables such as level of education and professional activity might compete with the bilingual advantage, acting as possible research confounds.

### **3.8. Stimuli**

Different visual (picture, words) and auditory stimuli were used according to the experimental paradigm of each task. They are described in detail in the relevant chapters.

### **3.9. Data**

All the experiments used are Reaction Time (RT) based behavioural tasks and hence the response latency or RT i.e., the time taken for response is the main data for the analysis. The interaction of this latency with respect to various factors, like congruency were analysed using a statistical software package.

#### **3.9.1. Data Trimming**

The RT data obtained from the experiments was first cleaned of errors which includes no responses and wrong responses. Then the outliers were removed using z score normalization. Outliers are reaction times that are either on the excessively higher side or lower side with significant deviations from the distribution of observed RT.

### **3.9.2. Statistical Procedure**

All the analysis carried out for this research was done on R (version 4.1.1). For each of the experiments Analysis of variance (ANOVA) and Linear Mixed Modelling (LMM) was used for analysis of the data. For all of the experiments, a full Linear Mixed Effects (LME) model was first built with all the fixed effects and random effects. The effects which did not improve the model and did not show any significance (Barr, 2013) were removed. Then a model with RT as the dependent variable and fixed effects for each experiment was fitted. The model was built by using the *lme4* package, analysis of variance was done using *anova()* function within the *LmerTest* package and *emmeans* package was used for pairwise comparison on R. The visual representation of the various data sets was done using graphs and plots with R packages like *ggplot 2* and *phonR*.

### **3.9.3. Analysis Procedure**

For experiment 1 and 2, the data was analysed according to the block for each group and then a combined analysis of both the groups. Experiment 3 was analysed according to the group and then a combined analysis of both the groups. Experiment 4 was analysed first according to the language block and then a combined analysis. Experiment 5 was also first analysed group wise and then a combined analysis was done. For experiment 6, the data was analysed according to condition type first and then cue type for each group and then a combined analysis was done. For experiment 7, the data was analysed groupwise and then combined analysis. For experiment 8, analysis of the data was done according to the language and then a combined analysis of both the language.

### **3.10. Ethics**

All the participants gave informed consent (see appendix D) for their participation in the experiments.

### **3.11. Chapter Summary**

The current chapter described, the methodology used for this study. It gives a description of all the standardised questionnaires used in the study and also provides in detail the various

types of experiments adapted for the study. All these experiments are established measures for behavioural language processing studies. Finally, the chapter concludes with the procedures employed in the process of experiment designing, data collection and analysis.



**CHAPTER: 4 ROLE OF CULTURALLY SPECIFIC CUES ON PROCESSING**



## 4.1. Introduction

Many countries have population that are essentially bilingual at the very least and multilingual in general. Often the languages known to them are not formally learnt but are picked up in social context, just as a matter of mutual convenience or historicity. In such societies, like in India for example, one's awareness of the others' language/culture is part of the subtle nuances of daily conversations. Minute cues are taken care of while conversing, as evident from code-mixing and code-switching practices.

In such societies, the listeners/interlocutor's identity is rather relevant, and thus salient, for pragmatic purposes. This is applicable in both intra and inter community communicative situations. In case of intra-community conversations, grammatical features, like pronouns, or registers to be used may differ. In case of inter-community conversations, many factors such as the mono/bilingual status of the other person, education level etc., are crucial aspects to be taken into account. For example, in case of a conversation between educated members of two different linguistic groups, English might be picked up as a lingua franca. But in other cases, it might be a local language. The interlocutor's role has already been investigated as a significant predictor of the bilingual behaviour in many studies (Martin, Molnar & Carreiras, 2016; Li et al., 2013; Zhang et al., 2013; Kroll & McClain, 2013). Martin, Molnar & Carreiras, 2016 showed that the visual display of the interlocutor predicts the language even before the onset of the auditory-linguistic signal. Visual images and faces linked to different cultures of the bilingual either facilitate or inhibit language production. (Li et al., 2013; Zhang et al., 2013; see also Kroll & McClain, 2013). The picture of faces has been argued to be less of representative of interlocutors and more of a socio-cultural icon or symbol (Martin et al., 2016) because the real language background of those faces cannot be discerned. However, the same may not be true when the said picture shows more than just the face. If the participant is able to fathom the language background of the person due to the prevalent social condition, the results may be different as found by Kapiley & Mishra, 2018. The role of such important social cues on language related tasks is a promising area to be investigated in terms of executive control, as constant juggling among languages and related cues can be expected to result in finer control mechanisms.

In this regard, research on Indian bilinguals has already shown that bilinguals are sensitive to the proficiency level of the interlocutor (Kapiley & Mishra, 2018) in case of voluntary naming tasks. While subtle social information about interlocutors is found to impact the task

results, the role of (non-human) cultural context has elicited mixed results (Roychoudhuri et al., 2018; Som et al., 2018). The relevant cues are found to have an effect on the tasks while non-relevant (for the task) cues have thrown in mixed results. One crucial difference between the studies by Roychoudhuri et al., 2018 and Som et al., 2018 is the language pair used. While Roychoudhuri's participants had English as their second language, Som chose to have participants speaking two indigenous languages. Studies on Indian bilinguals are few and far between and the existing work points towards possibilities of heterogeneity of result, depending on the language pair chosen, among other possible variables, necessitating further investigation. In this regard, this chapter uses cultural context as cues and studies inhibitory control in bilingual language comprehension as well as domain general control mechanisms. In order to do so, this group of experiments looked at this question in three different types of bilingual groups, where the relative status of the L2, method in which the L2 was acquired and social equations among the groups vary. This gives the opportunity to look at some of the finer aspects of bilingual experience and their interaction with the control mechanisms.

## **4.2. Chapter Overview**

In this chapter, the role of cultural context in bilingual language processing is investigated in four different experiments comprising of two translation equivalent task, one lexical decision task and one Flanker task. The chapter begins with the objective of the chapter followed by detailed discussion on all the four experiments. The chapter concludes with a summary of the findings and observations from the experiments.

## **4.3. Objective of the Chapter**

This chapter looks at the role cultural background plays in bilingual language processing. The cultural aspect of the speaker's background may include specific aspects of the lived experience, like dresses, food items, certain culturally specific iconic structures and so on. In literatures that look at the impact of these artefacts on language processing, we find a strong connection between the two. The presence of the culture specific cue tends to activate the language of which it is a part, thus showing negative impact in mismatch conditions (Jared et al., 2013; Zhang et al., 2013), and facilitation in matched conditions. This impact has been mainly reported in production studies. In this chapter, findings from the domain of language

comprehension are reported. The main objective of the chapter is to investigate if bilingual comprehension is inhibited by mismatched cultural cues.

While the literature reports a strong correlation between the presence of culture cue and response latency, the same need to be investigated in different types of bilingual settings, as the bilingual experience has a reasonable probability to interact with the type of interaction. It is also the objective of the current research, to study the nuances of bilingual experiences using different task conditions, with different types of bilingual groups.

Languages that are learnt socially, by virtue of sharing social-cultural space with other communities have different power structure. Unlike in case of English, this type of bilingualism allows for biculturalism along with bilingualism. The second language, in this case, is learnt as a matter of necessity. For example, in case of the state of Assam, the dominant language is the state official language Assamese. All other communities living in this state would invariably learn this language, even if they do not prefer to learn the same formally. Take for example, the Bodo –Assamese bilinguals (Bodos are a tribal community in Assam). The dominant Assamese however do not learn the Bodo language. In a country like India, it is also possible to learn a second language even when the social pressure of official language is not present. This is true of many communities that live side by side and share the social space. On the other hand, second language like English is almost always learnt in formal settings. The second language, in this case, is not strictly speaking, represented by a community in the same way as Assamese is. English is an official language that is part of life at certain levels and in certain domains. These are the two types of bilingualism that are studied in this chapter.

In this regard, this chapter, based on the use of culture cues, takes into account three different types of bilingual groups; two groups are bicultural bilingual groups, speaking two heritage languages as L1 and L2, sharing the same geographical location with L2 speakers. One group out of these two has an L2 that is also the prestige/powerful language of the region. The second setting has two groups, who speak each other's language, thus differentiating them from the first group. Neither of these two languages is the official language, thus reducing the 'power' factor.

The third group is different from the first two. This group has English as their L2 and is, in many ways, representative of the usual pool of participants in such studies. This group was

studied as a comparison with the earlier groups to ascertain how much of the nuances of control mechanisms are due to the nature of the second language and its status.

Four experiments were carried out that included linguistic as well as non-linguistic tasks. Linguistic tasks included translation recognition task and lexical decision task. While looking at bilingual language comprehension and the role of culture specific cues on the same, the presence/absence of domain general cognitive control was also probed, using Flanker task, with one of the groups.

Below each of the four experiments are introduced:

- a. In the first experiment, Rongmei-Meitei bilinguals took part. Salient features of this group are: they speak a Naga language, Rongmei, as their first language and Manipuri language Meitei (state official language of Manipur, the state where they reside) as their second language. The Rongmei Nagas in Manipur are part of larger Rongmei groups spread over many states in the north east of India. The two languages they speak have distinct social positions in terms of hierarchy. Meitei, the L2, being the official language of the state, is more powerful and used for all official purposes. Rongmei, on the other hand, is the language of the community, part of their identity. In this experiment, cartoonized pictures of a man and a woman wearing the *traditional dresses* were used as cues. Since tribal dresses are unique to the specific tribe, the presence of the figure wearing the particular dress would serve the purpose of an interlocutor from either one's own tribe or that of the other. Depending upon the direction of translation, these cues can either match or mismatch with the target word. A mismatch condition, thus, can be a 'Rongmei dressed' cue as prime for a Meitei target word and can result in higher response latency. On the other hand, matched condition may result in lower latency. The study also examines if the effect of the cue depends on age and living conditions of the respondents. The older generation of the Rongmei tribe continue to live in their district, which means their daily lives are closely connected to the Meitei community and language. However, the younger generation has moved out to bigger cities for education and jobs, and thus has more cosmopolitan lives. Keeping this in mind, the study was carried out among two groups of Rongmeis (more details in the next section). Further, the experiment also examines if the effect of the cues and age group has any relationship with the translation direction.

To investigate this angle, the study was carried out in two blocks: first language to second language translation (L1-L2 henceforth) and second language to first language translation (L2-L1 henceforth). The prediction was that, owing to adjacency (both cultural and linguistic) effect, the bilingual group would show higher inhibitory control in terms of ignoring irrelevant cues (cartoon figures wearing culture specific dress) and this would reflect in response latencies that may not have significant differences in congruent and incongruent conditions. However, some difference in terms of age group and translation direction are expected.

- b. The second set of experiments took the same question to a different bilingual setting, with *two* groups taking part in the study. In this set of experiments, the role of culture specific cues was investigated using a comprehension task; however language switching cost as an indicator of control mechanism also needed to be examined. The design of the experiment was based on these two primary goals. This study was carried out in the state of Nagaland in Northeast India. Both of these studied groups are ethnic Naga groups: Ao and Sangtam. The two groups speak their own varieties of Naga languages: Ao and Sangtam. Interestingly, both of these groups speak each other's language, which is a rare phenomenon, because typically, the more powerful group does not learn the language of the less powerful ones and it is always the burden of the less powerful group. These two groups have resided side by side since time immemorial and learnt each other's language socially. The social hierarchy, with respect to the languages, is not strict as neither of the languages has the 'official' status, as the state official language of Nagaland is English. This gives an interesting vantage point to study bilingual attitude while minimising the 'status' factor. Also, in terms of community, the two groups here reside in their own home state, Nagaland and are part of the larger Naga identity. This is different from the first study where the communities represented by the two languages are rather different, Naga and Meitei.

In this experiment, language direction was an inbuilt factor and switch trials saw a switch between the appearance (on the screen) of the first and second language words. This way, this does not form a regular language switch trial, but is a manipulation of the same. Switch cost has been an important aspect of bilingual

language control literature. Along with the inter-relationship between domain general executive control and bilingualism, there is a domain specific control mechanism that also has received attention. This is the area of bilingual language control. This type of control is investigated using a switching paradigm, commonly using a production task. Bilinguals incur a cost (in terms of delay) when they need to name an object in a language other than the one used just before and this cost is often found to be asymmetric. This means switching from one's weaker language (often the L2) to the stronger first language (L1) incurs more cost than vice versa (Meuter & Allport, 1999; Gollan, Kleinman, & Wierenga, 2014), although sometimes the switch cost is found to be similar as well, in case of balanced bilinguals (Costa & Santesteban, 2004; Costa, Santesteban, & Ivanova, 2006). The asymmetric switch cost has been explained through inhibition of non-target language or selective activation of one language relative to the other. (Allport & Wylie, 1999; Green, 1998). Like production studies, comprehension based studies also found evidence of switch cost in various task conditions; e.g. lexical decision task (Declerck & Philipp, 2015; Orfanidou & Sumner, 2005; Thomas & Allport, 2000; von Studnitz & Green, 1997), a semantic categorization task (Declerck & Grainger, 2017; Macizo, Bajo, & Paolieri, 2012; von Studnitz & Green, 2002), and a number categorization task (Hirsch, Declerck, & Koch, 2015; Jackson et al., 2004). However, in case of comprehension studies, this is not as robust as that of production studies. As Declerck et al., 2019 points out, several studies have found switch cost in specific cases while others did not find the cost at all (Bultena, Dijkstra, & van Hell, 2015; Declerck & Grainger, 2017; Hirsch et al., 2015; Hut et al., 2017; Jackson et al., 2004; Struys et al., 2018). In a finding unique to comprehension-based investigation, few researchers even found switch benefit as opposed to cost when different manual response was elicited from participants across two trials (Thomas & Allport, 2000; von Studnitz & Green, 2002; Orfanidou & Sumner, 2005).

Thus, experiment 2 looked at the inhibitory control in the face of incongruent cultural cue on comprehension in two groups of bilinguals who speak indigenous/heritage languages as their first and second language. This area is a relatively remote and rural one. This experiment also looked at the question of switch cost. The focus of the second experiment was to investigate how the

control mechanism associated with bilingualism plays out in the given socio-cultural and linguistic background and if there are differences in this mechanism in terms of linguistic and non-linguistic tasks. Thus, specific aims of the study were to probe the existence of cognitive control, through role of interlocutor, in bilingual comprehension task. The interlocutors were simulated by the use of traditional attires representative of the tribes taking part in the study. Secondly, if the two communities under study have any significant difference in response in the same task conditions. Thirdly, the existence of switch cost and if language switching has any interaction with the cues.

- c. The existence of domain general cognitive control (that is widely reported as ‘bilingual advantage’) is also investigated through a Flanker task in the third experiment. In this, the participants were same as that of experiment 2.
- d. The final experiment i.e., the fourth experiment of this chapter tried to examine the effect of cultural proximity and distance in bilinguals’ language processing using a non-heritage language as L2. In this experiment, the Ao bilinguals with English as L2 and Ao as L1 were taken. This experiment meant to juxtapose with experiment 1 and 2, in the sense that in experiment 1 and 2, both L1 and L2 were heritage languages belonging to the same language family and so were closely related. The cultures of the communities were also not distant and the people of these communities were in close proximity and contact with each other for a long time. However, in experiment 4, the Naga culture and the western culture are so far apart from each other and although there is the influence of western culture through western education and mass media, the Ao people still maintain a very distinct cultural identity. The language families of Ao and English are also very distant with the former belonging to the Sino-Tibetan family and the latter to the Germanic family. Thus, in this experiment, it is expected that the linguistic and cultural distance will have an effect on the word recognition task and show the effect of the incongruent culture cue as was seen in previous studies with culturally and linguistically distant bilinguals (Zhang et al., 2013; Li et al., 2013; Jared et al., 2013). The purpose of this experiment was to find out if the cultural and linguistic distance do matter when it comes to experiments on the effect of culture cue. It is possible that the more distant the languages and culture, the more chances of the disruption in word recognition. The disruption may happen either

way. Though L2 has been found to be adversely affected by L1 cues, in case of a dominant L2, disruption may be seen in L1 as well.

Detailed analysis of each of the experiments follows.

#### **4.4. Experiment 1**

The first experiment is an investigation into the nature of bilingual processing in comprehension, in Rongmei-Meitei (first language: Rongmei; second language: Meitei) bilinguals in India's Northeast. The study is not intended towards finding bilingual advantage or lack thereof by juxtaposing a bilingual group with a monolingual one. Rather, this is an attempt to check whether this bilingual population (which has some unique features hitherto not investigated) shows inhibition in case of mismatched interlocutor, and if the processing behaviour is different in different generations of speakers. Reports from such groups of bilinguals are hitherto not widely reported in the literature. There are some features of this group in particular and many other such groups in India, in general, that motivate this investigation. These are:

- The two communities representing the two languages belong to two different ethnic groups, with strict linguistic and cultural identities, within the larger Indian identity.
- The communities speaking the two languages (i.e., the Rongmei and the Meitei people) live side by side, leading to some amount of cultural closeness, as opposed to, say, Chinese-English or Hindi-English bilinguals.
- The two languages of the bilingual are genetically close, i.e., they belong to the same language family.
- The second language (L2) of the Rongmei community is the state official language and domains of usage of the languages are strict. First language (L1) is used only at home and within the community. However, the younger generation uses L2 for within-group communication as well.
- The two groups of Rongmei-Meitei bilinguals studied here also speak at least two or more languages (Hindi, English), which is often inevitable in India.

- It is common practice to carry out experimental research on participants from the student population of a university. These students may have different places of origin, and thus can have subtle influence on the outcome of the result. It is an important factor for complex, multicultural societies. For example, in Roychoudhuri et al., 2016, the subjects were Bengali students in universities, who would have come from many places in the state of West Bengal or even other states. In contrast, this study has all its participants from one particular place (Tamenglong district in Manipur state of India) thus controlling other contributing factors.
- The study uses cartoonized pictures of people representing the indigenous identity, through their attire. It is important to mention here that the tribal/indigenous groups of North East India adhere to their identity and each group can be identified by their respective dresses. They are also proud of their linguistic and cultural heritage, pointing to the fact that the pictures would immediately signal the linguistic identity of the person depicted. Apart from the dresses, the cartoons 'look' same. Hence, unlike the Chinese-English studies using faces, these figures activate a *narrower* identity as opposed to *race*.

#### **4.4.1. Geographical Distribution**

The Rongmeis are ethnically Naga people, living in the State of Manipur. They were left in the state of Manipur when the state boundaries were drawn. However, they identify themselves as Naga and follow Naga culture and customs. There is a separate State for Nagas, namely Nagaland. Living in the state of Manipur, they have to learn Meitei, the state official language of Manipur. The state of Manipur is bounded by Nagaland to the north, Mizoram to the South, Assam to the west and Myanmar in the east. The state capital is the city of Imphal.

The population of the state consists of Meitei, Kuki, Naga and Pangal people, who speak Tibeto-Burman languages and dialects. Meitheilon/ Meitei is the language of the non-tribals and it is spoken in and around the state capital Imphal. The hills surrounding Imphal are inhabited by tribals like Kukis and Nagas, who speak languages mostly belonging to the Kuki-chin under Tibeto-Burman language family. The Rongmei speakers in Manipur can be found mostly in the district of Tamenglong. The ancestral place of the Rongmei tribe lies in the mountain ranges of Tamenglong (Manipur) and adjacent mountain areas of Peren

(Nagaland) and Haflong (Assam). The varieties of Rongmei differ as one goes from north-west to central parts of Manipur valley where the speakers are also found. But still, they are mutually intelligible to one another.

#### **4.4.2. The Relationship of Languages in Terms of Family Affiliation**

The Rongmei language is spoken by a population of 350,580 (2011 census) people. The Bible was translated in Rongmei in 1989. In terms of population and size, Meitheilon/ Meitei speakers are the largest and the only language of the state to be included in the Eighth Schedule of the constitution of India. It is the official language and also the lingua-franca of the state. Meitheilon/Meitei is spoken by a population of 1.76 million (2011 census) people. Meitei is often classified under the Kuki-Chin-Naga group. Before the eighteenth century, Meitei Mayek was used to write the language until it was replaced by Bengali. Latin script exists as an informal, but fairly consistent practical use. It is “practical” in the sense that it does not use extra-alphabetical symbols, and can therefore be produced easily on any standard keyboard. It is extensively used on the internet. This script on the whole offers a transparent, unambiguous representation of Meitei sound system, although the tones are usually not marked. Recently, Meitei Mayek was reintroduced as the writing system of Meitei and has been taught in schools since the early 1980’s. With the rapid penetration of mass media like radio, television, film, press etc., the speakers of minority languages have to depend on Meitei or the language of wider communication such as Hindi and English. Figure 4.1 gives the classification of Tibeto-Burman languages in northeast India and also indicates the language family to which the two languages under study in this experiment i.e., Rongmei and Meitei belongs to.

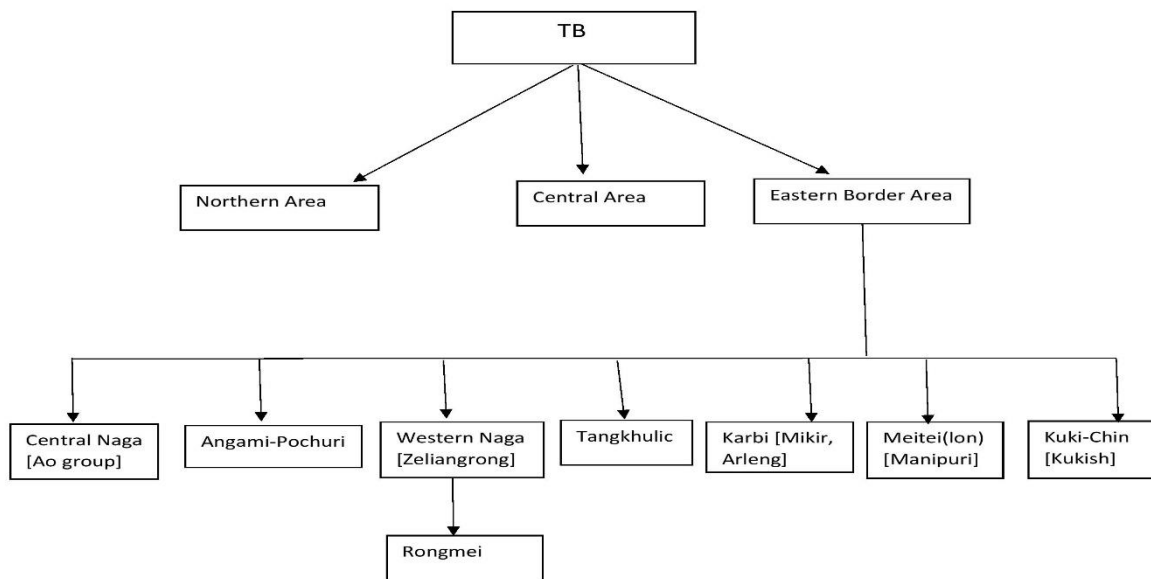


Figure 4.1. Classification of Tibeto-Burman languages of Northeast India (Mark W. Post and Robbins Burling 2017)

#### 4.4.3. Mutual Social Relationship between the Languages and Communities

Manipur attained its statehood in 1972 and since then the state has often witnessed a tug of war between the dominant Meitei language and dozens of tribal languages that include Rongmei. The language problem in the state erupted in the 1980's when the state government tried to introduce Meitei as a compulsory subject up to class 10. The problem again erupted in 1992 with the insertion of Meitei in the Eight Schedule (Singha, M.N, 2014). Recently, Union Public Service Commission (India's central recruiting agency, that conducts examinations all over the country for Group A and B level Central Services) tried to impose Meitei as a compulsory subject in Civil Service (mains) examination for the candidates from Manipur. The introduction of Meitei Mayek has also created a lot of social unrest from various sections of people in the state. The existing educational system is such that out of 29 or more tribal languages only few languages are taught in school while the others remain neglected. However, Rongmei is taught in schools from class 1 till class 12.

#### 4.4.4. Research Questions

1. How does culture specific cues (dresses on cartoonized people in this case) interact with response latency in a translation recognition task?
2. Does the cue interact with the translation direction?
3. Do young and older generation react differently to the same cue?
4. Does the environment of the bilinguals interact with the response latency?
5. Does the urban and rural setting of the participants have any role in processing?

#### 4.4.5. Participants

In order to have a better understanding of the background social setting, the study was carried out separately on two different groups of participants, who had different amount of immersion in the Manipuri socio-cultural ethos. The younger group is more multicultural and live outside the state of Manipur while the older group have never left Manipur and has lived all their life within the Manipuri (Meitei) society. Another factor that divides the two groups is the number of other languages used in daily life. The younger group lives in a city, which speaks neither of their L1 and L2; and the lingua franca is Hindi/English or Assamese.

Findings from similar studies points to an inhibitory effect, specifically in case of language production. However, such studies in comprehension are less. Since cognitive control is a domain general cognitive mechanism, it may affect both production and comprehension. Hence the authors have used a comprehension task in this work.

##### 4.4.5.1 (Group 1)

Participants (N =27) ranged in age from 18-33 years (Mean= 22.44, SD=3.23) and they live in Guwahati, Assam. They all grew up in the Tamenglong district in Manipur where Rongmeis are settled. The average amount of time they have spent outside Manipur is approximately 5/6 years. Some of them are students and some work in various concerns. Average education level of this group was graduation (some undergoing graduation). Participants gave informed consent for their participation in the study. The reason behind the choice of groups was to check whether the salient social scenario has any impact on the performance. All participants are native speakers of Rongmei (L1) and spoke Meitei as their second language (L2). Each participant completed a questionnaire which included questions on their language history and usage. The participants provided self-report ratings of age of

acquisition and rated their abilities in speaking, reading, writing and comprehension for Rongmei and Meitei on a scale of 1-7 (1=very poor, 7= native like). The self-report ratings are presented below in Table 4.1. The same participants took part in both blocks of the experiment, which was dependent on the direction of translation: L1-L2 and L2-L1.

*Table 4.1. Data from Questionnaire on the Age of Acquisition (AoA), Proficiency and Age of Usage of the two Languages in Various Domains of Group 1 Participants*

	<b>L1 M(SD)</b>	<b>L2 M(SD)</b>
Age of Acquisition (AoA)	1.29 (0.86)	6.40 (3.97)
Proficiency		
Reading	6.25 (0.69)	3.77 (1.64)
Writing	5.92 (0.89)	3.22 (1.47)
Speaking	6.59 (0.56)	5.18 (0.94)
Listening	6.48 (0.56)	5.40 (0.87)
Age of usage in various domains		
Home	1.70 (1.08)	3.59 (3.26)
Friends	3.11 (1.54)	8.92 (5.12)
Educational institutions	3.98 (1.44)	7.20 (3.58)

The self-report data collected from the questionnaire, we can see that the AoA for L1 was much earlier than L2 but both languages are acquired at an early age within the critical period. The proficiency in speaking and listening was given almost similar ratings, but in terms of reading and writing, the participants reported higher proficiency in L1 as compared to L2. This could be because L2 is mostly learned through social interactions. The table also depicts the age at which they started using both the languages in various settings. For the usage of the two languages in various domains, L1 was used at a much earlier age as compared to L2 at home, with friends/ social interactions and at educational institutions. For the participants, L2 which is Meitei is used as a form of communication in educational institutions in certain contexts like with friends but Meitei is not learned by the Rongmei-Meitei participants as a subject in schools.

#### **4.4.5.2 Participants (Group 2)**

The participants (N=27) of this group comprised of elderly Rongmeis, from Tamenglong in Manipur, the stronghold of the Rongmei tribe. They have never lived outside Manipur (age= 40-59; mean= 46.88, SD= 5.54). Owing to living in the state of Manipur, their day-to-day

exposure to Meitei is much higher and so is the social pressure of the dominant language. Average education level of this group is higher secondary school. All participants are native speakers of Rongmei (L1) and spoke Meitei as their second language (L2). Each participant completed a questionnaire which included questions on their language history and usage. The participants provided self-report ratings of age of acquisition and rated their abilities in speaking, reading, writing and comprehension for Rongmei and Meitei on a scale of 1-7 (1=very poor, 7= native like). The self-report ratings are presented in Table 4.2. The same participants took part in both blocks of the experiment, which depended on the direction of translation: L1-L2 and L2-L1. The participants gave informed consent for the study.

*Table 4.2. Self-report Rating on AoA, Proficiency and Usage in Various Domains for Group 2 Participants*

	<b>L1 M (SD)</b>	<b>L2 M (SD)</b>
<b>Age of acquisition (L1)</b>	2.03 (0.33)	7.03 (1.79)
<b>Reading</b>	6.07 (1.15)	3.44 (1.77)
<b>Writing</b>	5.74 (1.40)	2.92 (1.86)
<b>Speaking</b>	6.81 (0.38)	4.77 (1.22)
<b>Listening</b>	6.77 (0.49)	5.03 (1.13)
<b>Age of usage in various domains</b>		
<b>Home</b>	1.30 (0.60)	4.20 (1.98)
<b>Friends</b>	3.00 (1.65)	7.30 (4.80)
<b>Educational Institutions</b>	4.01 (1.40)	7.50 (4.62)

For this group of participants also, the reported rating for AoA was earlier for L1 as compared to L2. But both the languages were acquired early on in childhood within the critical period. In terms of proficiency, L1 was reported with higher proficiency as compared to L2 in reading, writing, speaking and listening skills. The participants also started using L1 at a much earlier age as compared to L2.

#### **4.4.6. Stimuli and Design**

*Stimuli:* This was a primed translation recognition task. The task was to identify whether the word pairs were translation equivalents or not. The prime consisted of 3 pairs (male & female) of cartoonised pictures of people wearing either a Rongmei or Meitei tribal attire or a neutral dress (jeans and white T-shirt). The translation equivalents used in this experiment

were selected in a norming experiment by 10 bilingual participants who did not take part in the main experiment. A total of 100 high frequency words were listed from publicly available resources and participants were asked to give the best translation for them in the other language. Same process was repeated for both the languages. Another group (N=10) rated the word pairs for frequency and aptness of translation. The word pairs with a score of 8 or above by 8 or more participants were selected for the experiment and this resulted in 40 non-cognate translation equivalents. A set of 40 non-translation equivalents were also created with a score of 8 and above and were used in both the blocks. So, together there were 80 pairs of words and they appeared in three conditions resulting in 240 trials in each of the blocks. All words were nouns and belonged to various semantic categories. Rongmei and Meitei share the same script, Latin and this is also the script used in the experiment. Meitei has another script, Meitei Mayek, but it was not used.

***Blocks:*** The experiment was carried out in two blocks depending on the direction of translation: L1-L2 and L2-L1. The words were presented in pairs and the first word in the pair was Rongmei (L1) in the first block (L1-L2) of the experiment and Meitei in the second block (L2-L1). The pairs were presented in random selection.

***Conditions:*** There were three conditions dependent upon the appearance of the prime with respect to the second word of the translation equivalent (TE hereafter). For the L1-L2 block, the three types of primes thus resulted in these conditions: congruent (Meitei dressed cartoon), incongruent (Rongmei dressed cartoon) and neutral condition (jeans and T short wearing cartoon). Similar three conditions were created for the L2-L1 block as well.

***Design:*** The presentation sequence was as follows: first a fixation point (“+”) appeared in the centre of the screen for 500ms, followed by the first word in the pair for 1000ms. This was followed by a cultural image picture that stayed on the screen for 500ms and then the second word of the pair was presented for 2000ms. If a response was not provided within 2000ms, the next trial started automatically. A schematic representation of a sample trial is represented below in figure 4.2.

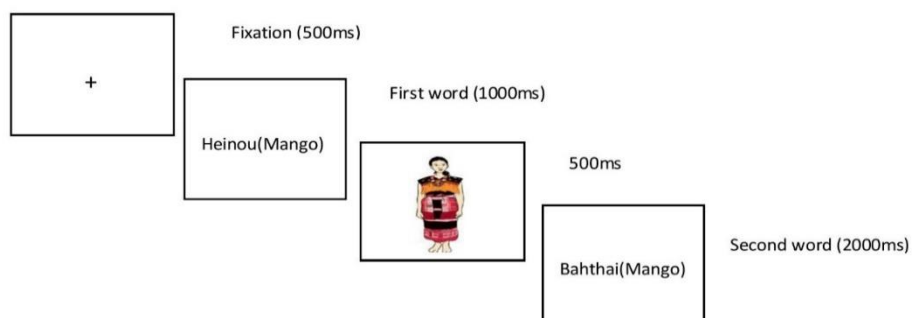


Figure 4.2. Schematic Representation of the Trial

#### 4.4.7. Procedure

The participants were tested individually in a quiet room. Verbal and written instructions about the task were given in English (in order not to prime any of the languages under study) before the experiment proper. All the participants were 10<sup>th</sup> grade passed and spoke and understood English to some extent. A local translator was also present to clarify any questions regarding the experiment and also to help in better communication of the instructions. Participants were told that they would be shown word pairs and were asked to decide whether the second word in a pair was a correct translation of the first word. They had to answer by pressing one of the two keys on the keyboard: '1' if the second word is the translation equivalent of the first word and '2' if it was not the correct translation. They were also told that a picture of a man or woman will appear on the screen but they need not do anything about it. Before the main experiment, the participants performed a training block of 18 trials.

*Tools:* The experiment was designed and presented using E-Prime 2.0 (Psychology Software Tools, Pittsburgh, PA) on an HP laptop computer. The statistical analysis of the data was carried out using R system for statistical computing (Ver. 4.1.1; R Development Core Team, 2009) under the GNU General Public License (Version 2, June 1991).

#### 4.4.8. Results: Group 1

The data was analysed group-wise first, followed by a combined analysis of both the groups.

Few of the participants' data had to be removed due to technical (data entry errors) and other errors (like, being unresponsive). The final list had twenty (20) participants from young group and twenty-two (22) participants from the old group. Incorrect responses were considered as error. Only correct responses were considered for analysis. Also, response latencies below 250ms were removed. Only valid responses were considered for the data analysis. Hence these were included in the analysis. Outliers were removed and the mean reaction time of the correct responses and the mean errors were assessed via an analysis of variance using the *anova ()* function within the *LmerTest* package. Then the data was further assessed with post-hoc pairwise comparison using the *emmeans* package on R.

#### L1-L2

In the reaction time analysis of the correct responses, the incongruent condition had the highest RT ( $M=832.85$ ,  $SD=320.14$ ) followed by the congruent condition ( $M=830.89$ ,  $SD=320.74$ ) and the neutral condition ( $M=830.89$ ,  $SD=320.74$ ). But the ANOVA analysis revealed that the main effect of the incongruent condition was not significant,  $F(2, 2859)=0.962$ ,  $p=0.382$ . Figure 4.3 shows the means RTs across conditions.

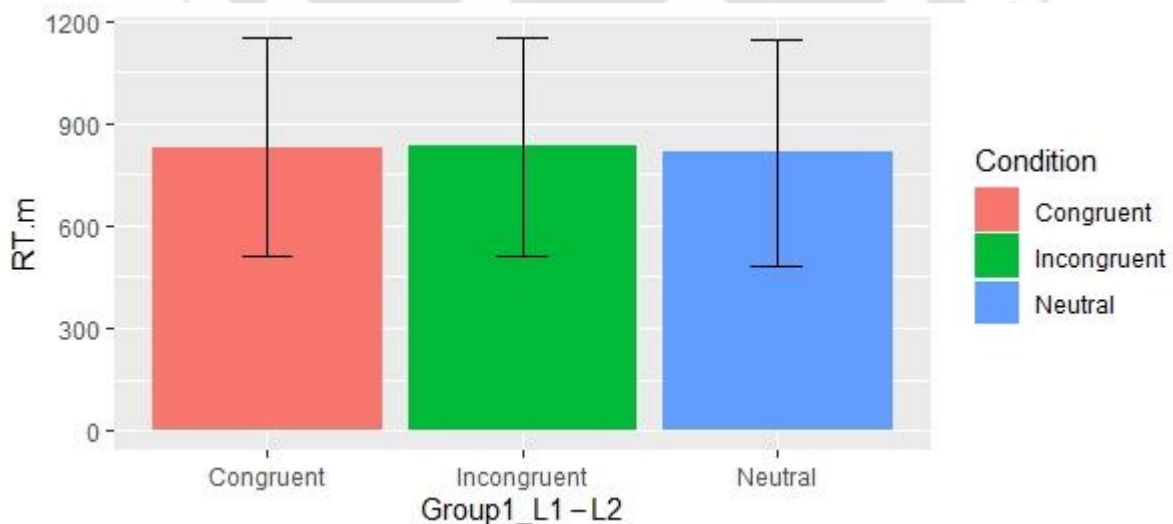


Figure 4.3. Box Plot Showing the Mean RTs Across Conditions in L1-L2 Language Direction for Group 1

Bonferroni post-hoc analysis was done with the conditions as the within subject factors. The results revealed that there was no statistically significant difference between the congruent and incongruent condition, with higher RT in the incongruent condition by  $4.28ms$ ,  $SE=13.9$ ,  $t=0.308$ ,  $p=1.00$ , congruent and neutral with higher RT in the congruent condition by  $15.42ms$ ,  $SE=14.0$ ,  $t=1.101$ ,  $p=0.81$  and incongruent and neutral condition with higher RT in the incongruent condition by  $19.70ms$ ,  $SE=14.0$ ,  $t=1.407$ ,  $p=0.48$ . Table 4.3 presents the results of the post hoc analysis.

Table 4.3. Post-hoc analysis results

contrast	estimate	SE	Df	t.ratio	p value
Congruent-Incongruent	-4.28	13.9	2859	-0.308	1.00
Congruent - Neutral	15.42	14.0	2859	1.101	0.81
Incongruent - Neutral	19.70	14.0	2859	1.407	0.47

### Error Analysis

Error analysis also did not show the main effect of the incongruent condition,  $F(2, 1851)=0.306$ ,  $p=0.736$ . Bonferroni post hoc analysis also revealed that there was no statistically significant difference between the congruent and incongruent condition with higher RT in the congruent condition by  $18.5ms$ ,  $SE=28.8$ ,  $t=0.642$ ,  $p=1.00$ , congruent and neutral condition with higher RT in the congruent condition by  $20.2ms$ ,  $SE=28.5$ ,  $t=0.709$ ,  $p=1.00$  and incongruent and neutral condition with higher RT in the incongruent condition by  $1.7ms$ ,  $SE=28.5$ ,  $t=0.060$ ,  $p=1.00$ .

### L2-L1

In the reaction time analysis of the correct responses in the L2-L1 direction, incongruent condition had the highest RT ( $M=805.50$ ,  $SD=315.43$ ) followed by the congruent condition ( $M=783.19$ ,  $SD=308.81$ ) and the neutral condition with the lowest RT ( $M=770.29$ ,  $SD=304.01$ ). The ANOVA results revealed that the main effect of the incongruent condition was significant,  $F(2, 3277)=3.648$ ,  $p=0.026$ . Figure 4.4 shows the mean RTs of the conditions in L2-L1 direction.

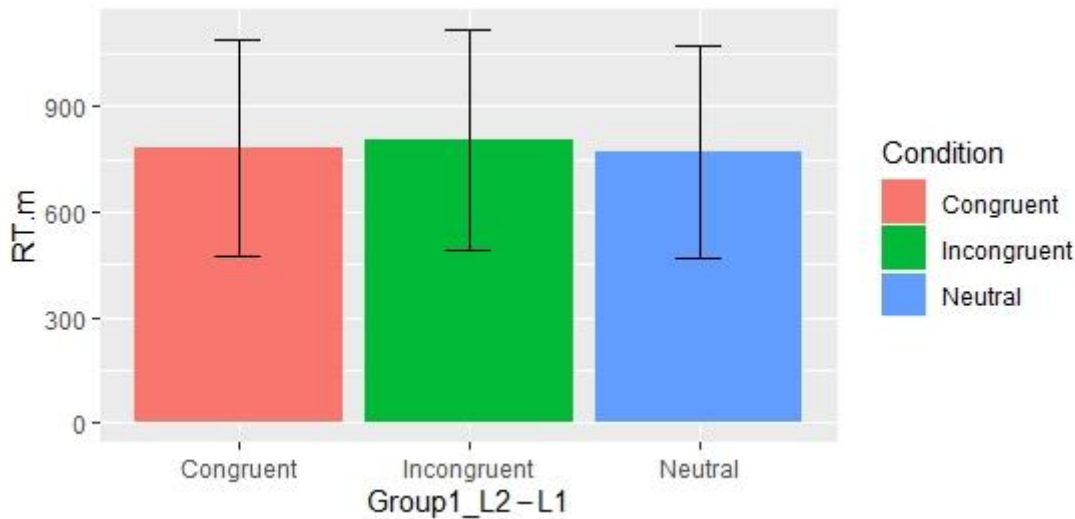


Figure 4.4. Box Plot Showing the Mean RTs Across Conditions in L2-L1 Direction for Group 1

Bonferroni post-hoc analysis results revealed that there was statistically significant difference only between the incongruent and neutral condition with higher RT in the incongruent condition by  $35.2ms$ ,  $SE=12.5$ ,  $t=2.822$ ,  $p=0.014$ . There was no statistically significant difference between the congruent and incongruent condition with shorter RT in the incongruent condition by  $20.2ms$ ,  $SE=12.5$ ,  $t=-1.622$ ,  $p=0.3149$  and congruent and neutral condition with higher RT in the congruent condition by  $15ms$ ,  $SE=12.5$ ,  $t=1.20$ ,  $p=0.69$ . Table 4.4 presents the results of the post-hoc analysis.

Table 4.4. Post-hoc analysis.

contrast	estimate	SE	Df	t ratio	p.value
Congruent-Incongruent	-20.2	12.5	3277	-1.622	0.3149
Congruent - Neutral	15.0	12.5	3277	1.200	0.6908
Incongruent - Neutral	35.2	12.5	3277	2.822	0.0144

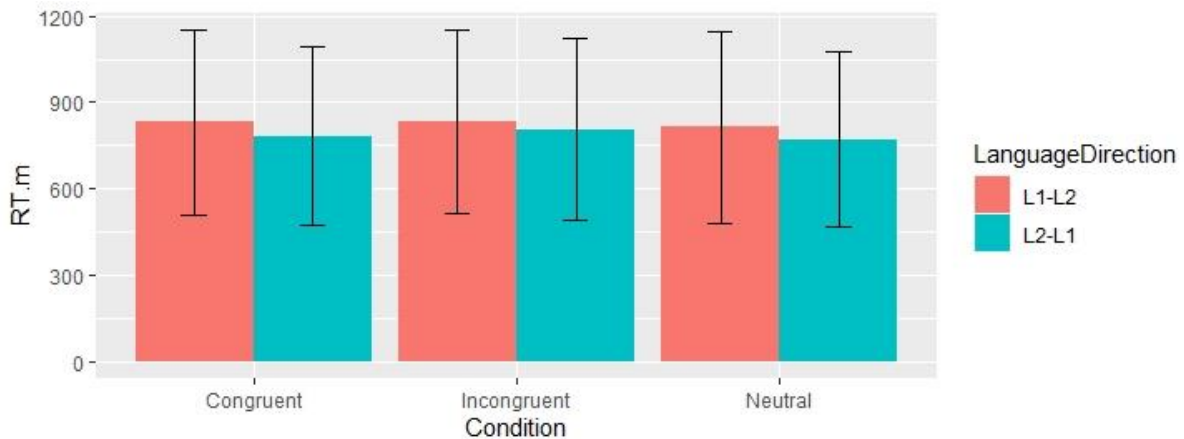
### Error Analysis

Error data analysis did not show the main effect of the condition,  $F(2, 1401)=0.842$ ,  $p=0.431$ . Bonferroni post-hoc analysis revealed that there was no statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by  $30.9ms$ ,  $SE=30.8$ ,  $t=-1.002$ ,  $p=0.9502$ , congruent and neutral condition with higher RT in the congruent condition by  $11ms$ ,  $SE=31.0$ ,  $t=0.356$ ,  $p=1.00$  and incongruent

and neutral condition with higher RT in the incongruent condition by  $41.9ms$ ,  $SE=30.3$ ,  $t=1.381$ ,  $p=0.50$ .

### Combined Analysis of the Two Blocks

Figure 4.5 depicts the pattern of reaction time for each condition in both language direction.



*Fig 4.5. Box Plot Showing the Distribution of Mean Reaction Time Across Conditions and Language Directions*

In the combined analysis of the two blocks, no interaction was found between the language direction and condition,  $p=0.54$ . Tukey's post-hoc analysis was conducted which revealed that there was statistically significant difference between L1-L2 block and L2-L1 block in the congruent condition with higher RT in the L1-L2 direction by  $51.34ms$ , ( $SE=13.4$ ,  $t=3.845$ ,  $p=0.005$ ), incongruent condition, with higher RT in the L1-L2 direction by  $32.73ms$ ,  $SE=13.3$ ,  $t=2.453$ ,  $p=0.0266$  and neutral condition with higher RT in the L1-L2 direction by  $49.80ms$ ,  $SE=13.5$ ,  $t=3.702$ ,  $p=0.0006$ . Thus, in all the three conditions L1-L2 had higher RT as compared to L2-L1 and it was also significant.

No statistically significant difference was seen in the error analysis in terms of language direction, condition or interaction between language direction and condition (see appendix Q).

### Discussion

In the results of the data analysis, we could not find any statistically significant difference between the three conditions in the single language blocks. But in the mixed block, we found that L1-L2 had higher RT in all the three conditions and it was also statistically significant.

This means that translation was faster from Meitei to Rongmei even in the presence of distractor cues than Rongmei to Meitei.

#### 4.4.9. Results Group 2

##### L1-L2 Block

In the reaction time analysis of the correct responses in L1-L2 block, the highest reaction time was incurred by the incongruent condition ( $M=897.77$ ,  $SD=339.13$ ), followed by the neutral condition ( $M=878.70$ ,  $SD=326.54$ ) and the lowest RT was incurred in the congruent condition ( $M=878.70$ ,  $SD=326.54$ ). Figure 4.6 shows the mean reaction time of the three conditions in the L1-L2 block for group 2. ANOVA analysis revealed that there was no statistically significant difference between the conditions,  $F(2, 3066)=1.446$ ,  $p=0.236$ .

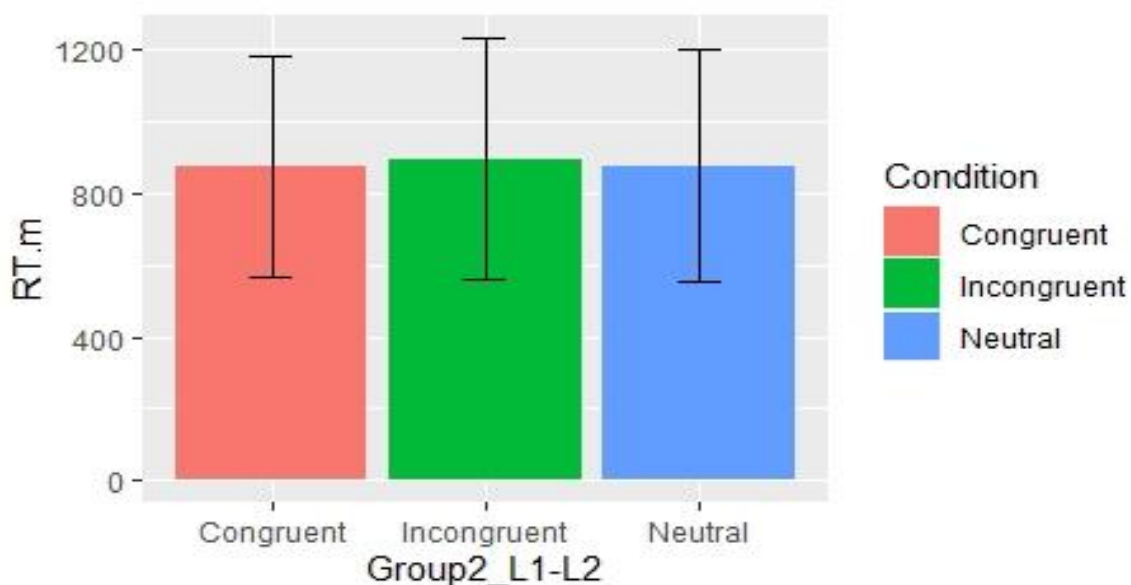


Figure 4.6. Mean Reaction Time of All the Three Condition in L1-L2 Block for Group 2

Bonferroni post hoc analysis has revealed that there was no statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by 22.1ms,  $SE=13.0$ ,  $t=-1.701$ ,  $p=0.26$ , congruent and neutral with shorter RT in the congruent condition by 1.6ms,  $SE=13.1$ ,  $t=-0.122$ ,  $p=1.00$  and incongruent and neutral condition with higher RT in the incongruent condition by 20.6ms,  $SE=13.0$ ,  $t=1.57$ ,  $p=0.34$ . Table 4.5 presents the post hoc analysis of RTs in L1-L2 for Group 2.

Table 4.5. Post hoc analysis for RTs in L1-L2 for Group 2

contrast	estimate	SE	Df	t ratio	p value
Congruent - Incongruent	-22.1	13.0	3066	-1.701	0.2671
Congruent - Neutral	-1.6	13.1	3066	-0.122	1.0000
Incongruent - Neutral	20.6	13.0	3066	1.579	0.3433

### Error Analysis

In the error analysis also the main effect of the condition was not seen with no statistically significant difference between the condition,  $F(2, 1631)=1.077, p=0.341$ . Bonferroni post-hoc analysis also revealed no statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by 45.64ms,  $SE=31.3, t=-1.456, p=0.43$ , congruent and neutral with shorter RT in the congruent condition by 8.29ms,  $SE=31.1, t=-0.266, p=1.00$  and incongruent and neutral condition with higher RT in the incongruent condition by 37.36 ms,  $SE=31.3, t=1.193, 0.69$ . Table 4.6 presents the post hoc analysis of the RTs in L1-L2 for Group 2.

Table 4.6. Post hoc analysis for error RT in L1-L2 for Group 2.

contrast	estimate	SE	Df	t ratio	p value
Congruent - Incongruent	-45.64	31.3	1631	-1.456	0.4368
Congruent - Neutral	-8.29	31.1	1631	-0.266	1.0000
Incongruent - Neutral	37.36	31.3	1631	1.193	0.6993

### L2-L1 block

Reaction time analysis of the correct responses revealed that the neutral condition had the highest RT ( $M=803.80, SE=296.11$ ) followed by the incongruent condition ( $M=802.84, SE=291.31$ ) and the shortest RT incurred in the congruent condition ( $M=779.78, SE=280.31$ ). ANOVA analysis revealed that there was statistically significant difference between the three condition,  $F(2, 3383)=0.704, p=0.012$ . Figure 4.7 shows the mean reaction times across the three conditions in L2-L1 block.

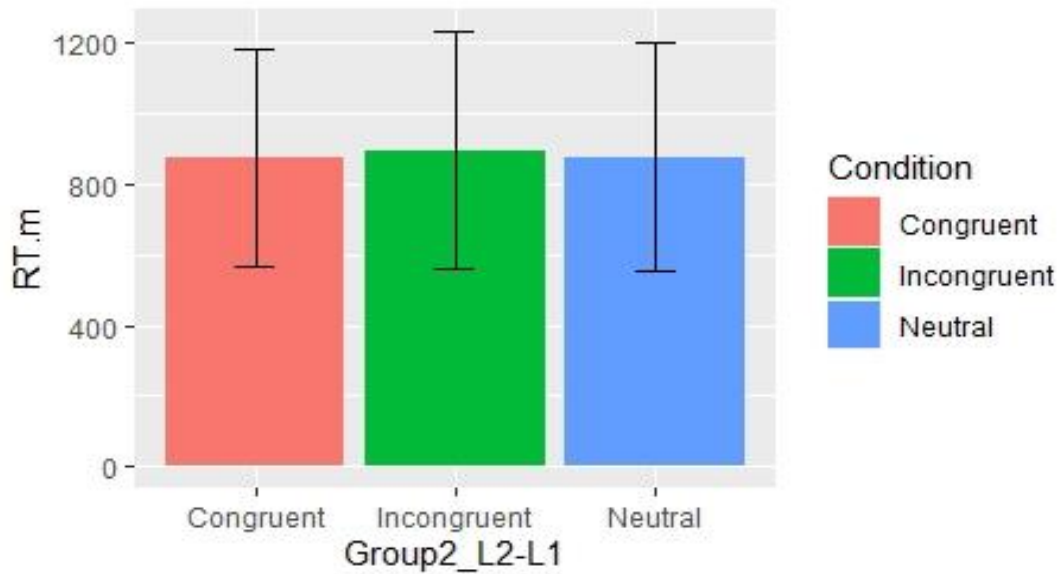


Figure 4.7. Box Plot Showing the Mean RTs Across Conditions in L2-L1 Block

Table 4.7 presents Bonferroni's post-hoc analysis which revealed that there was statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by  $25.92ms$ ,  $SE=1.04$ ,  $t=-2.488$ ,  $p=0.038$  and between congruent and neutral condition with shorter RT in the congruent condition by  $27.47ms$ ,  $SE=10.5$ ,  $t=-2.624$ ,  $p=0.026$ . However, there was no statistically significant difference between the incongruent and neutral condition with shorter RT in the incongruent condition by  $1.55ms$ ,  $SE=10.4$ ,  $t=-0.149$ ,  $p=1.00$ .

Table 4.7. Post hoc analysis results

contrast	estimate	SE	Df	t ratio	p value
Congruent - Incongruent	-25.92	1.04	3383	-2.488	0.0386
Congruent - Neutral	-27.47	10.5	3383	-2.624	0.0262
Incongruent - Neutral	-1.55	10.4	3383	-0.149	1.0000

### Error

The error data analysis did not show any statistically significant difference between the conditions,  $F(2, 1280)=0.376$ ,  $p=0.687$ . Post hoc analysis also did not reveal any statistically significant difference between the congruent and incongruent condition with higher RT in the congruent condition by  $29.23ms$ ,  $SE=34.3$ ,  $t=0.852$ ,  $p=1.00$ , congruent and neutral condition with higher RT in the congruent condition by  $20.57ms$ ,  $SE=34.1$ ,  $t=0.604$ ,  $p=1.00$  and

incongruent and neutral condition with shorter RT in the incongruent condition by  $8.66ms$ ,  $SE=34.0$ ,  $t=-0.255$ ,  $p=1.00$ .

### Combined Analysis of the Blocks

Figure 4.8 depicts the mean reaction time of the two blocks across the three conditions, i.e., congruent, incongruent and neutral conditions.

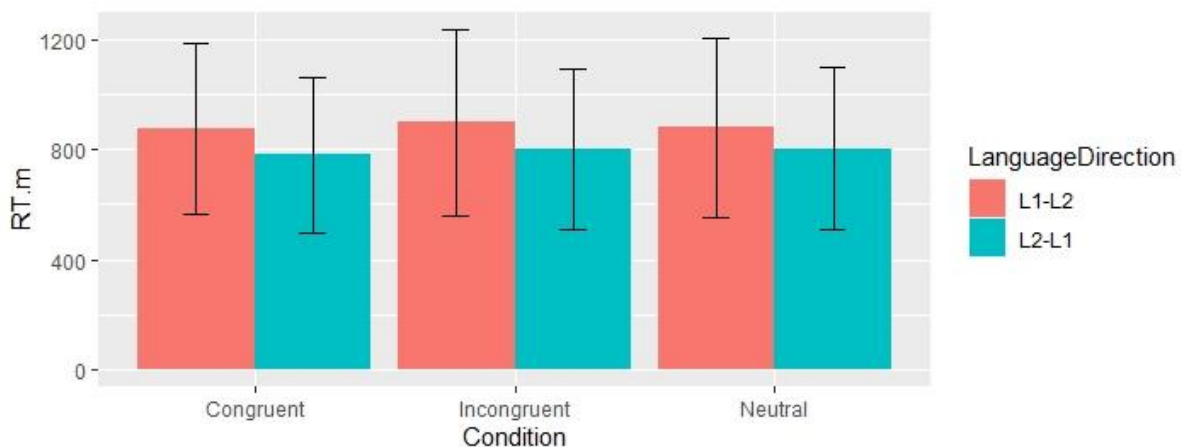


Figure 4.8. Box Plot Showing the Mean RTs of the two Blocks Across Condition

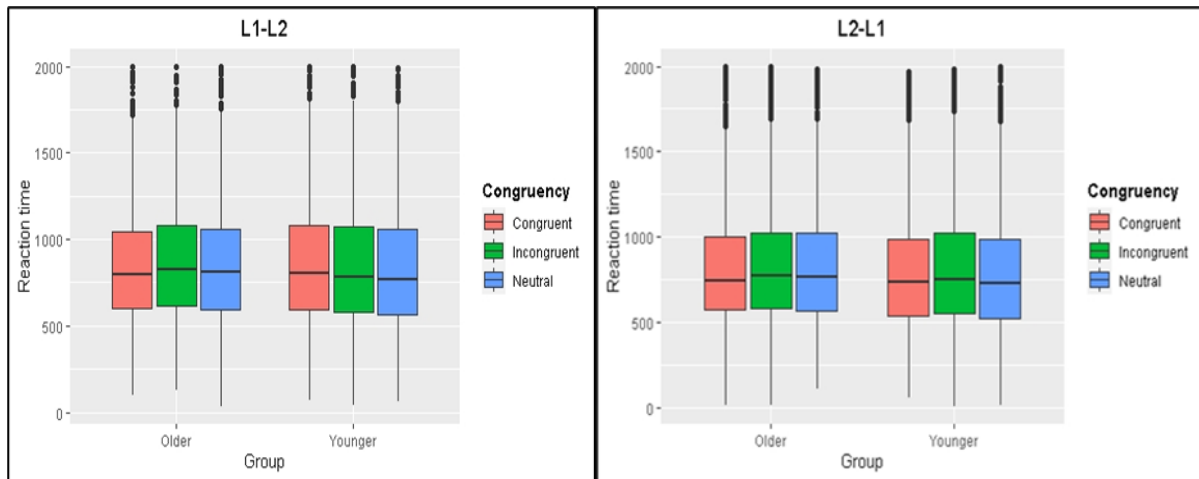
In the combined analysis of the two blocks, Tukey's post hoc analysis was conducted which revealed that there was statistically significant difference between L1-L2 and L2-L1 direction in the congruent condition with higher RT in the L1-L2 direction by  $94.35ms$ ,  $SE=12.3$ ,  $t=7.645$ ,  $p<0.0001$ , incongruent condition with higher RT in the L1-L2 direction by  $91.33ms$ ,  $SE=12.2$ ,  $t=7.483$ ,  $p<0.0001$  and neutral condition with higher RT in the L1-L2 direction by  $70.14ms$ ,  $SE=12.3$ ,  $t=5.696$ ,  $p<0.0001$ . In all the three conditions L1-L2 direction had incurred higher RT.

### Discussion

The results of the data analysis revealed that the effect of the incongruent condition was seen only in the L2-L1 block. In the combined analysis of both the blocks also, we saw that L2-L1 direction had higher RT as compared to L1-L2 and it was also statistically significant. This means that the presence of the Meitei specific cue disrupted Rongmei recognition whereas such an effect was not seen on Meitei recognition.

## Combined Analysis of Group 1 and Group 2

Figure 4.9 shows the box plot of distribution of data across reaction times, language direction, congruency level and age groups. The reaction times present positive skewness and outliers in the right tail of the distribution. It should be noted that Figure 4.8 shows that reaction times show the same behavior regardless of age group and direction of translation.



*Figure 4.9. Box Plot Showing the Distribution of Data Across Reaction Time, Groups and Congruency Level for Each Language Directions*

Figure 4.10 shows the box plot of distribution of error rates across language direction, congruency level and age groups. The rates present positive asymmetry and have a greater number of outliers in the right tail of the distribution when the translation direction goes from L2-L1 within the oldest age group. It can be seen in the plots that the error rate is higher on average in the group of young people. Finally, there is less variability in the results when the language direction goes from L1-L2 than when the direction goes from L2-L1 and the average error rates are slightly lower for the L2-L1 direction.

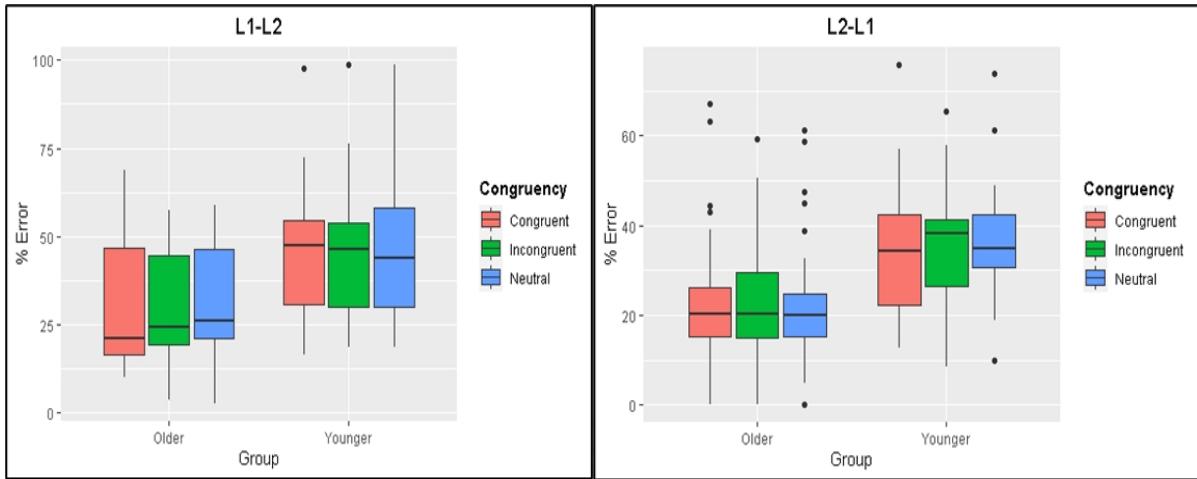


Figure 4.10. Box Plot Showing the Distribution of Data Across Error Rate, Groups and Congruency Level for Each Language Directions

Table 4.8 presents the fixed effects estimated using linear mixed model with RT as the dependent variable and conditions (congruent, incongruent and neutral), language direction (L1-L2 vs L2-L1), group (older and younger) and their interactions as fixed effects. The results show that the effect of age is significant, which means that the average reaction time of young people is  $227.69ms$  greater than the older group. The direction of the language is also a significant effect with the average reaction time  $25.47ms$  shorter when the direction of the translation goes from L2-L1 compared to L1-L2. There is a significant difference in reaction time when we consider an incongruent image compared to a neutral image. When an incongruent image is used during translation, the average reaction time is  $16.55ms$  longer than when a neutral image is used. The joint effect of age group and direction of translation on reaction time is significant.

Table 4.8. Fixed Effects Estimated with Fully Parameterized Linear Mixed Model (LMM) for RT

Variable	RTs		
	Estimate	SE	P
Fixed effects			
(Intercept)	409.1135	216.2662	0.0585
Age	9.2919	4.5191	0.0451
GroupYounger	227.6949	117.6228	0.0587
GenderMale	26.7784	40.0807	0.5072
LanguageDirection2	-25.4703	6.9475	0.0002
CongruencyCongruent	3.6929	6.1990	0.5514
CongruencyIncongruent	16.5535	6.1751	0.0074
GroupYounger:LanguageDirection2	-39.7521	10.2669	0.0001

Note. SE = standard error.

#### 4.4.10. Discussion

The study examined the effect of cultural congruency of cues on response latencies in a primed translation recognition task. Of particular interest, within this broad objective, were the role played, if any, by language directions [(L1-L2) and (L2-L1)] and age-groups (having different socio-cultural context). Based on very few available data from similar non-immigrant, bilingual populations, it was hypothesized that owing to the linguistic and cultural proximity of the group under study with that of the other community (representing the second language), the inhibitory effect of cultural icons/interlocutors associated with the other language may not be present. If inhibitory effects are found, it was expected that the older group may show more influence of the cues than the younger. This is due to the fact that the

two groups have different social reality, primarily with respect to immersion in the Meitei context. The study also looked at translation direction as a predictor of language dominance. The L2 (as it often is in most parts of India) is the state official language, it is used in education and work domains and has a dominant status.

- A. The results prove the above-mentioned prediction, as the main effect of ‘condition on the response is found to be non-significant. The interaction of ‘condition’ with the other variables of ‘language direction’ and ‘group’ were also not significant. The result can be understood in terms of context of bilingual practice, something that has become of utmost importance in the discourse on bilingualism. Not all bilinguals are same and the results of the present study is a pointer to that. The bilinguals in the present study speak Rongmei as their first language and Meitei as their second language, apart from speaking at least one or two more languages. This is particularly true of the younger group. Hence the socio-cultural context of these bilinguals is markedly different from a group that may speak only two languages. Similarly, in a country like India, diversity is part of life and is almost taken for granted. Thus, the cultural distance leading to an inhibiting effect is not visible. By virtue of being part of a complex cultural setting, the bilinguals would have imbibed a stronger inhibitory control in their responses. The complexity of the socio-cultural setting in this case has to do with the fact that the second language is represented by a community, who live side by side with the Rongmeis and at the same time, each of the groups is aware of their own separate identity, which they fiercely protect. Like many other groups in Indian society, the Rongmeis are also bicultural to a large extent. Such a scenario can probably lead to a better inhibitory control in a domain general way. More studies need to probe this angle. Another way to understand the findings may be through the Adaptive control Hypothesis (Green & Abutalebi, 2013). The language-use context for this bilingual group can be classified as dual-language context, where the two languages are available for use for all domains, but use of one or the other depends on the conversation participants/speakers. This makes the speakers observant at all times. The theory predicts higher conflict monitoring and interference suppression in dual language context and the results obtained in this study points towards that possibility. The choice of languages for this study, that belong to the same language family, also brings in the linguistic-distance as a factor as proposed by Sorman, 2018. As per his

theory, one expects higher control in such cases as opposed to bilinguals speaking language belonging to different language families.

- B.** The main effect of ‘group’ is not found significant with respect to ‘condition’. This negates the hypothesis that the proximity to Meitei people/language may have an effect on how the culture specific cues are to be processed. Both groups are found to exercise similar inhibitory control in case of mismatch conditions. Exposure to more languages in a more diverse environment, in this case, does not seem to have any added advantage for the young group under study. However, within ‘condition’, the difference between groups is found in terms of translation direction L1-L2. For the same conditions, translation from second to first language, the groups did not show significant difference.
- C.** Language direction turns out to be an important predictor of response latency in both groups of participants and in both congruent and incongruent conditions. Overall response latency in L2-L1 direction is less than that of L1-L2 translation direction for both groups. It is predictable as translation from second language to first is expected to be easier as proposed by Revised Hierarchical Model (Kroll & Stewart, 1994).

The overall results thus indicate that the cultural ecology of the group of bilinguals reported here does have an impact on the comprehension process. In other words, since differences in terms of language and culture are part of life here, so is inhibiting responses to irrelevant cues. The task at hand did not need to take into account the presence of the cue and thus was ignored.

#### **4.5. Experiment 2**

This experiment, focused on Nagaland, is an effort towards addressing some of the important aspects comprising the bilingual experience, namely role of the type of second language, relationship between the speakers’ two languages, social factors attached to the languages, habitat/environment of the speakers and so on. In this experiment, two groups of bilinguals from Nagaland with a unique social background were investigated. The participants in this experiment were from Ao and Sangtam community of Longkhim, a small town in Tuensang district of Nagaland. These two communities have lived in the same town for decades, ever since the Ao evangelical mission took it upon themselves to evangelise and spread the gospel in the early 20<sup>th</sup> century to the eastern parts of Nagaland. Because of the missionary works, the first school in the Sangtam area was established by the Aos. Prior to the Ao missionaries,

the Sangtam tribe were illiterate, but with the coming of the missionaries, education was introduced to the people. The impact of the Ao missionaries in terms of language was that, since the Sangtam language was not written still, the missionaries used the Ao language for teaching in school (reading, writing) including textbooks and preaching in the church (singing, praying). Slowly, the Ao language became the language used for reading or writing and for church purposes. This trend went on for decades till the late 20<sup>th</sup> century. Even though Sangtam has its own books and taught in schools today, the impact of the Ao missionaries and Ao language can still be seen today specially in this small town. Most of the Sangtam community in this town prefers to read the Ao vernacular newspaper to this day. Socially also the impact can be seen till date. The Ao missionaries settled in the Sangtam area and even though they are from a different tribe, they call the place home. The two communities live in mutual harmony and share the language and culture. The language usage pattern in this area is quite unique. Both the communities speak and understand each other's language although the Ao language has been held in higher esteem for decades. There is existence of inter-tribe marriage and thus bilingual children who learn both the languages at the same time.

In light of such nuances, the aim of the experiment was to explore if the high proficient bilinguals, who are also bicultural, exhibit cognitive control in terms of interference inhibition.

#### **4.5.1. Geographical Distribution**

Nagaland is a state in Northeast India, sharing its borders with Arunachal to the North, Assam to the west, Manipur to the South and Myanmar to the east. It attained its statehood on 1<sup>st</sup> December 1963. The state has 1.9 million population (2011 census) with English as its official language. The Ao tribe primarily reside in Mokokchung district of Nagaland. Mokokchung is also called as the land of pioneers and considered as the cultural and intellectual capital of Nagaland.

Tuensang is located in the eastern part of Nagaland inhabited by four major tribes, the Changs, the Yimchangers, the Khamniungans and the Sangtams. The Sangtam tribe can also be found in Kiphire district and are one of the major tribes in Nagaland. Figure 4.11 presents the map of Nagaland.



Figure 4.11. Map of Nagaland. <http://www.onefivenine.com/india/villag/state/Nagaland>

#### 4.5.2. Comprehension Task

The experiment was carried out with two groups of bilinguals. The languages under consideration are Ao and Sangtam. These are spoken by the tribes of the same name in an area called Longkhim in Nagaland. Interestingly, these two groups speak both the languages fluently, with neither language as dominant: the Aos speak Ao as first language (L1) and Sangtam as second language (L2) and the Sangtams speak Sangtam as L1 and Ao as L2. Nagamese is the common third language. They also know English and Hindi to some extent. The tribal groups live side by side and thus the learning of each other's language has been social, the medium of education even at primary level being English. Neither group speaks English in daily life, it is only a medium of instruction; everyday conversation takes place in both Ao and Sangtam, often interchangeably. Nagamese, a creole is yet another language used by them, mostly if either Ao or Sangtam prove inadequate in certain contexts. To sum up, the groups use Ao, Sangtam and Nagamese in social contexts.

As mentioned earlier, the dominant communities do not usually learn the weaker group's language, even socially. This makes it rare to find groups who speak each other's language equally fluently. Thus, it is not possible to compare Hindi-English bilinguals with English-Hindi bilingual groups. One may argue why such a comparison should be necessary. Though

it's not mandatory, research can take this factor into account in order to check if the outcomes are a result of reasons other than just bilingualism per se (as mentioned above).

#### **4.5.3. Design**

This study was carried out using E Prime 3.0. This is a primed translation recognition task. The task was to identify if the word pairs were translation equivalents. The response was recorded via key-press; keys were customized specifically for this purpose (1 for Yes, 2 for No).

The order of the words depended on the language direction. For example, L1-L2 direction trials would have L1 word followed by L2 word and vice versa. The rationale for using both directions of translations was that the direction will give the information as to which language translation is more affected by the cues. And which of the cues will have either positive OR negative effect on the recognition (this is indicated by higher/lower Reaction Time).

The manipulation in this case was the insertion of an image as a prime between the two stimuli. This image was a cartoon figure, wearing the traditional dress belonging to either Sangtam or Ao tribe. The cues were of three types: congruent (when the image of the dress matched the language of the second word, i.e., target language), incongruent (mismatch between image and target language's word) and neutral (images of trees, mountains, rivers). The three conditions remained same for all trials. The experiment was carried out in two language directions and on both the language communities.

There were single language-direction blocks, (where the sequence of L1 and L2 words remained same throughout trial) and mixed/switched direction blocks [in which the first and the second word (L1 or L2) changed depending upon a cue on the screen]. The presentation of the blocks was thus: single-direction block was followed by switch block, which was followed by another single block. The mixed trial was designed to give the impact of cues on recognition in case they have to switch languages. In the mixed block the language direction appeared in random selection and each participant saw a different sequence of trials. This was done to remove the chance of familiarity as well as repetition. So, a comparison between single language block and mixed block reflects the cost (time lapse) between these two conditions on the task at hand.

Participants were given 18 practice trials before each block and they consisted of 6 trials for each condition ( $6 \times 3 = 18$ ).

#### 4.5.4. Stimuli

For stimulus, at first, 100 translation equivalent word pairs were selected from local newspapers, popular books etc. These were then rated for accuracy in a norming experiment by 10 bilinguals each from both the language groups; these twenty persons did not take part in the main experiment. On the basis of the rating, 30 non-cognate translation equivalents and 30 non-translation equivalents (total word-pair: sixty) with a score of 8 and above were chosen for the task. All words were nouns and belonged to various semantic categories.

Thus, the stimuli arrangement was like this:

Number of word pairs: Sixty (all the pairs were used for all conditions)

Conditions: Three (congruent, incongruent and neutral)

Language direction: Two (L1-L2 & L2-L1)

Number of blocks for each language direction: Three (one *switched block* between two *single blocks*).

Thus, each participant saw a total of 1080 trials.

A sample trial procedure is depicted below in figure 4.12.

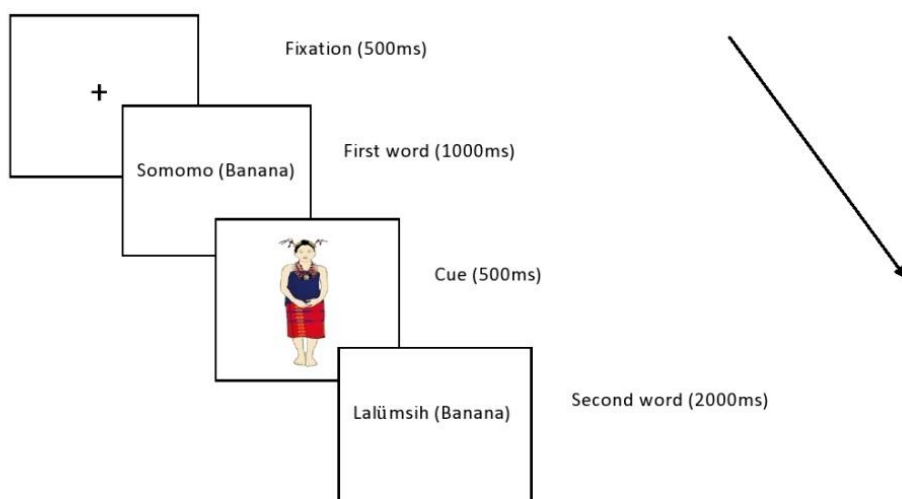


Figure 4.12. A sample trial procedure

#### 4.5.6. Participants

40 participants from Ao community (speaking Sangtam as their L2) and 40 participants from Sangtam community (who speak Ao as L2) participated in this experiment.

The participants gave self-report ratings on the proficiency and age of acquisition on a scale of 1-7 (very poor-excellent). The data obtained on the language usage in various domains suggests that apart from using their own L1 in their homes, L2 is commonly used in other domains. Table 4.9 presents the self-report ratings on the age of acquisition and proficiency.

*Table 4.9. Self-report Rating on AoA and Proficiency*

*Note. M=mean, SD=standard deviation*

	<b>Group1 (25-45 years)</b>		<b>Group2 (25-45 years)</b>	
Age	35.3 (M)	6.56 (SD)	37.63(M)	6.28(SD)
AoA	Ao(L1) 1.03	Sangtam(L2) 2.93	Ao(L2) 3.33	Sangtam(L1) 1
Proficiency				
Reading	5.68	4.62	5.43	5.73
Writing	5.37	3.82	4.56	5.46
Speaking	6.75	6.62	6.33	6.9
Listening	6.86	6.75	6.7	7

From the self-report rating, we can see that the AoA for L1 and L2 is similar for both the groups. Both the languages are acquired at a very young age. The reported proficiency level is also similar for both languages for both groups in terms of reading, writing, speaking and listening skills. Thus, the participants/ bilinguals in this experiment are balanced bilinguals.

Table 4.10. Percentage of Language Usage in Different Domains (A= Ao, S=Sangtam, N=Nagamese)

	Home	Siblings	Peer-group	Worship	Market
Group1 Ao-Sangtam bilinguals	69.99% (A)	56% (A)	93.33%(A/S)	86.66%(A)	100% (S/N/A)
Group2 Sangtam-Ao bilinguals	73.33%(S)	73.33%(S)	83.33%(S/A)	86.63%(S)	90.99%(S/N/A)

As shown in table 4.10, we can see that both Ao and Sangtam is used by the participants in social interactions (peer group and market) along with Nagamese and their respective L1 at home, place of worship and in interactions with siblings.

#### 4.5.7. Result

The data was analysed group wise first and then a combined analysis of both the groups was carried out. In the group wise analysis, the data was analysed according to the blocks. For the analysis, no response and incorrect responses were removed. Responses in the range of 250-2000ms were considered. Outliers were also removed using z-score normalization.

##### 4.5.7.1. Ao-Sangtam

###### L1-L2 Block

Reaction time analysis of the correct response data revealed that the highest RT was incurred in the incongruent condition ( $M=1046.95$ ,  $SD=401.79$ ) followed by the neutral condition ( $M=1025.84$ ,  $SD=382.68$ ) and congruent condition ( $M=1006.99$ ,  $SD=396.67$ ). ANOVA analysis revealed that there was no statistically significant difference between the three conditions,  $F(2, 2626)=2.202$ ,  $p=0.111$ . Figure 4.13 shows the mean reaction times across conditions.

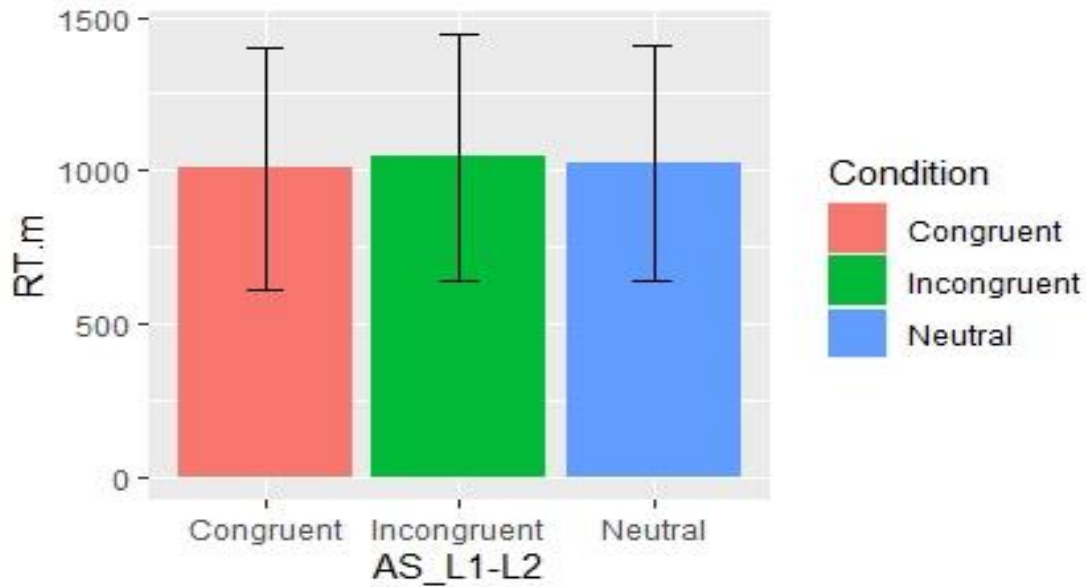


Figure 4.13. Box Plot Showing the Reaction Time Across Conditions

Table 4.11 presents Bonferroni post hoc analysis which also revealed that there was no statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by  $29.03ms$ ,  $SE=15.7$ ,  $t=-1.850$ ,  $p=0.1933$ , and congruent and neutral condition with shorter RT in the congruent condition by  $22.05ms$ ,  $SE=15.8$ ,  $t=-1.395$ ,  $p=0.489$  and incongruent and neutral condition with shorter RT in the neutral condition by  $6.98ms$ ,  $SE=15.8$ ,  $t=0.443$ ,  $p=1.00$ .

Table 4.11. Post hoc analysis for RT in L1-L2

contrast	estimate	SE	df	t ratio	p value
Congruent-Incongruent	-29.03	15.7	2626	-1.850	0.1933
Congruent-Neutral	-22.05	15.8	2626	-1.395	0.4893
Incongruent-Neutral	6.98	15.8	2626	0.443	1.0000

### Error

In the error analysis also the main effect of the conditions was not seen with no statistically significant difference between the three conditions,  $F(2, 155)=3.114$ ,  $p=0.57$ . Table 4.12 presents the results of Bonferroni post hoc analysis revealing that there is no statistically significant difference between the congruent and incongruent condition with higher RT in the

congruent condition by 247.9ms,  $SE=154$ ,  $t=1.608$ ,  $p=0.33$ , congruent and neutral with higher RT in the congruent condition by 173ms,  $SE=156$ ,  $t=1.109$ ,  $p=0.807$  and incongruent and neutral condition with higher RT in the neutral condition by 74.9ms,  $SE=152$ ,  $t=-0.491$ ,  $p=1.00$ .

Table 4.12. Post hoc analysis for Error RT in L1-L2

contrast	estimate	SE	Df	t ratio	p value
Congruent-Incongruent	247.9	154	137	1.608	0.3302
Congruent-Neutral	173.0	156	146	1.109	0.8078
Incongruent-Neutral	-74.9	152	138	-0.491	1.0000

### L2-L1 Block

In the reaction times analysis of the data, Neutral condition had incurred the highest RT ( $M=899.45$ ,  $SD=375.67$ ) followed by incongruent condition ( $M=872.67$ ,  $SD=371.23$ ). Lowest RT was incurred in the congruent condition ( $M=867.33$ ,  $SD=383.67$ ). ANOVA results revealed that there was statistically significant difference between the three conditions,  $F(2, 3075)=2.163$ ,  $p=0.0137$ . Figure 4.14 shows the mean reaction times across conditions.

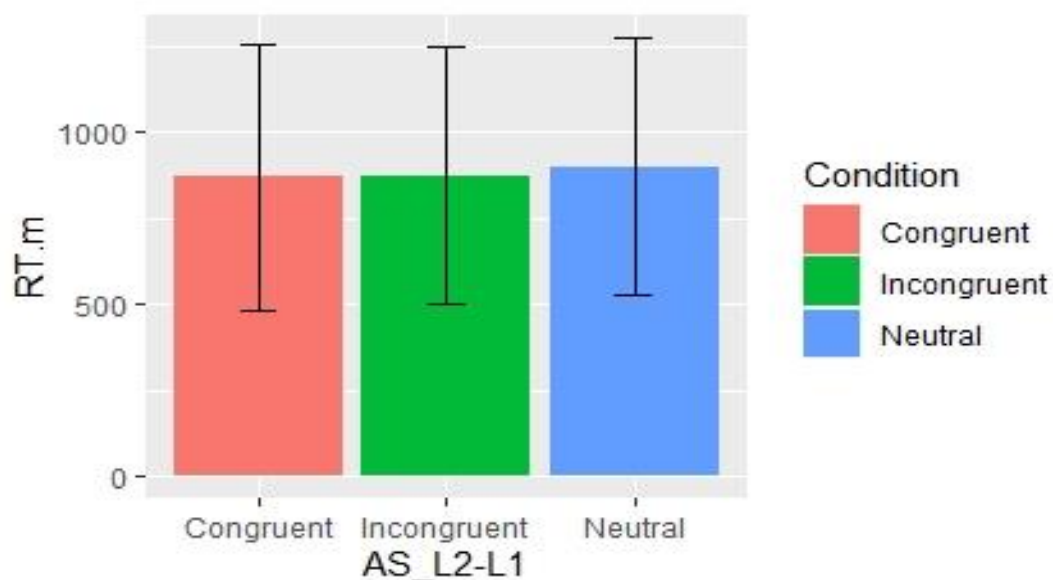


Figure 4.14. Box Plot Showing the Reaction Times Across Conditions in L2-L1

Table 4.13 presents the post hoc analysis which revealed that there was statistically significant difference only between congruent and neutral condition with shorter RT in the

congruent condition by 35.77ms,  $SE=13.3$ ,  $t=-2.696$ ,  $p=0.0212$ . No significant difference was found between congruent and incongruent condition with shorter RT in the incongruent condition by 4.74ms,  $SE=13.3$ ,  $t=-0.356$ ,  $p=1.00$  and incongruent and neutral condition with shorter RT in the neutral condition by 31.03ms,  $SE=13.3$ ,  $t=-2.337$ ,  $p=0.0585$ .

Table 4.13. Post hoc analysis for RT in L2-L1 for Ao-Sangtam Group

contrast	estimate	SE	df	t ratio	p value
Congruent-Incongruent	-4.74	13.3	3075	-0.356	1.0000
Congruent-Neutral	-35.77	13.3	3074	-2.696	0.0212
Incongruent-Neutral	-31.03	13.3	3074	-2.337	0.0585

### Error

In the analysis of the error data, no main effect of the conditions was found as there was no statistically significant difference between the condition,  $F(2, 135)=0.491$ ,  $p=0.613$ . Table 4.14 presents Bonferroni post hoc analysis which also did not show any statistically significant difference between the congruent and incongruent condition with higher RT in the congruent condition by 118.30ms,  $SE=133$ ,  $t=0.890$ ,  $p=1.00$ , congruent and neutral condition with shorter RT in the congruent condition by 6.02ms,  $SE=155$ ,  $t=-0.039$ ,  $p=1.00$  and incongruent and neutral condition with shorter RT in the neutral condition by 124.32ms,  $SE=154$ ,  $t=-0.806$ ,  $p=1.00$ .

Table 4.14. Post hoc analysis for Error RT in L2-L1 for Ao-Sangtam Group

	estimate	SE	Df	t ratio	p value
Congruent-Incongruent	118.30	133	132	0.890	1.0000
Congruent-Neutral	-6.02	155	135	-0.039	1.0000
Incongruent-Neutral	-124.32	154	134	-0.806	1.0000

### Mixed Block

In the RT analysis of the mixed block, within the congruent condition L1-L2 ( $M=751.58$ ,  $SD=324.50$ ) and L2-L1 ( $M=751.67$ ,  $SD=339.08$ ) had similar reaction times. In the incongruent condition, L1-L2 incurred higher RT ( $M=761.93$ ,  $SD=331.93$ ) than L2-L1 ( $M=732.08$ ,  $SD=327.36$ ). In the neutral condition also, L1-L2 had higher RT ( $M=763.90$ ,

$SD=339.47$ ) than  $L2-L1$  ( $M=750.03$ ,  $SD=329.44$ ). Thus, higher reaction time was observed in  $L1-L2$  language direction in incongruent and neutral condition in the mixed block. Figure 4.15, shows the mean reaction times for both language direction across conditions.

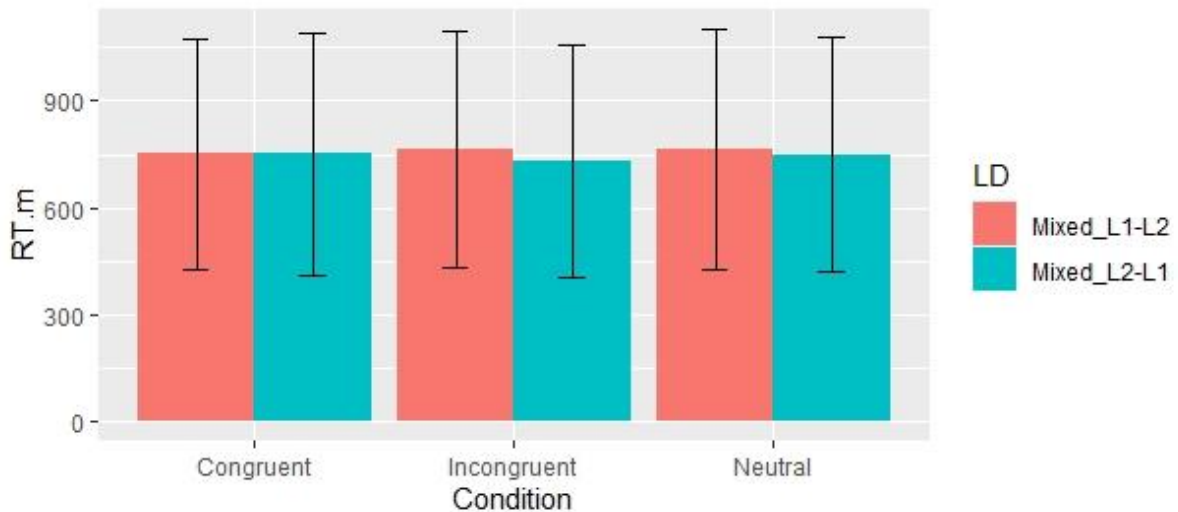


Figure 4.15. Box Plot Showing the Reaction Times Across Conditions for Both Language Directions

ANOVA analysis revealed that there was no statistically significant difference between the language direction,  $F(1, 6512)=3.102$ ,  $p=0.0782$  and condition,  $F(2, 6512)=0.478$ ,  $p=0.62$ . There was also no interaction between the language directions and conditions,  $F(2, 6512)=1.103$ ,  $p=0.33$ . Tukey's post-hoc analysis also did not reveal any statistically significant difference (see appendix R).

### Error

The error analysis also did not reveal any statistically significant difference between the condition,  $F(1, 252)=0.087$ ,  $p=0.76$  and language directions,  $F(2, 252)=0.035$ ,  $p=0.966$ . No interaction was also found between the language directions and conditions,  $F(2, 252)=1.616$ ,  $p=0.541$ . Post hoc analysis also did not reveal any statistically significant difference (see appendix R).

## Discussion

In the data analysis of the Ao-Sangtam group, no statistically significant difference was found even though incongruent condition had higher reaction time than congruent condition. Thus, the presence of the distractor cues did not result in disruption of the target language.

### 4.5.7.2. Sangtam-Ao

#### L1-L2 Block

The RT analysis of the data revealed that the highest response time was incurred in the neutral condition ( $M=943.03$ ,  $SD=374.61$ ) followed by the incongruent condition ( $M=935.08$ ,  $SD=389.56$ ). The shortest RT was observed in the congruent condition ( $M=922.73$ ,  $SD=384.94$ ). Figure 4.16 shows the mean reaction time across the three conditions in L1-L2 block.

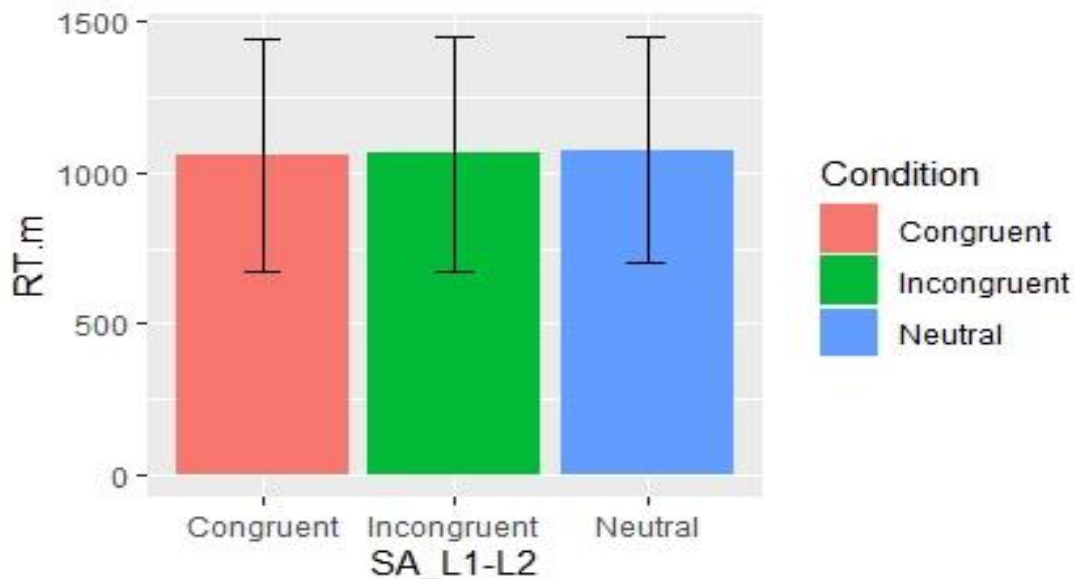


Figure 4.16. Box Plot Showing the Reaction Times Across Conditions

ANOVA results revealed that there was no statistically significant difference between the conditions,  $F(2, 3161)=0.679$ ,  $p=0.507$ . Table 4.15 presents the results of Bonferroni post hoc analysis which also showed that there was no statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by  $17.05ms$ ,  $SE=13.3$ ,  $t=1.278$ ,  $p=0.60$ , congruent and neutral condition with shorter RT in the

congruent condition by 24.02ms,  $SE=13.4$ ,  $t=1.795$ ,  $p=0.2183$  and congruent and neutral condition with shorter RT in the incongruent condition by 6.97ms,  $SE=13.4$ ,  $t=0.521$ ,  $p=1.00$ .

Table 4.15. Post hoc analysis for RT in L1-L2 for Sangtam-Ao Group

	estimate	SE	Df	t ratio	p value
Congruent-Incongruent	-17.05	13.3	3161	-1.278	0.6038
Congruent-Neutral	-24.02	13.4	3161	-1.795	0.2183
Incongruent-Neutral	-6.97	13.4	3161	-0.521	1.0000

### Error

In the error data analysis also, the main effect of the conditions was not seen as there was no statistically significant difference between the conditions,  $F(2, 139)=4.001$ ,  $p=0.312$ . Bonferroni post hoc analysis also did not reveal any statistically significant difference between the congruent and incongruent conditions with higher RT in the congruent condition by 142.5ms,  $SE=127$ ,  $t=1.125$ ,  $p=0.7879$ , congruent and neutral condition with shorter RT in the congruent condition by 59.5ms,  $SE=122$ ,  $t=0.487$ ,  $p=1.00$  and incongruent and neutral condition with shorter RT in incongruent condition by 202.0ms,  $SE=136$ ,  $t=1.481$ ,  $p=0.4225$ . The post hoc analysis result is presented on table 4.16.

Table 4.16. Post hoc analysis for Error RT in L1-L2 for Sangtam-Ao Group

contrast	estimate	SE	Df	t ratio	p value
Congruent-Incongruent	142.5	127	135	1,125	0.7879
Congruent-Neutral	-59.5	122	138	-0.487	1.0000
Incongruent-Neutral	-202.0	136	139	-1.481	0.4225

### L2-L1 Block

The reaction time analysis revealed that the highest reaction time was incurred in the neutral condition ( $M=1074.82$ ,  $SD=374.68$ ) followed by the incongruent condition ( $M=1060.35$ ,  $SD=390.17$ ). Congruent condition had the shortest RT ( $M=1053.63$ ,  $SD=384.24$ ). ANOVA analysis revealed that there was no statistically significant difference between the conditions

$F(2, 2535)=0.679, p=0.507$ . Figure 4.17 shows the mean reaction times across the three conditions in L2-L1 block.

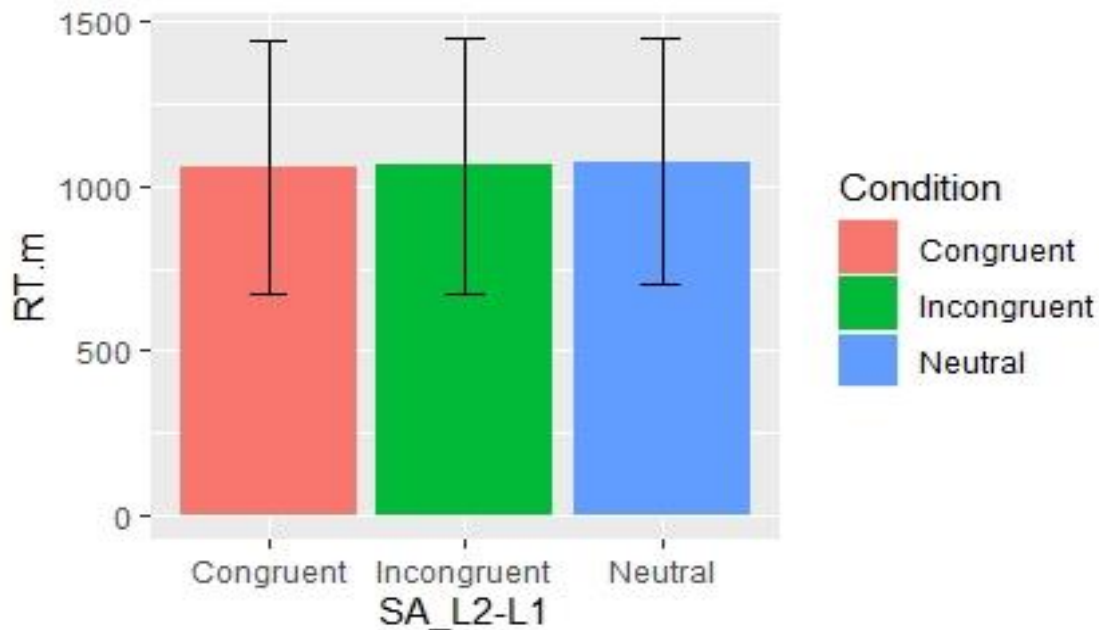


Figure 4.17. Box Plot Showing Reaction Times Across Conditions

Table 4.17 presents Bonferroni post hoc analysis which also revealed that there was no statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by  $1.32ms, SE=16.3, t=0.081, p=1.00$ , congruent and neutral condition with shorter RT in the congruent condition by  $18.26ms, SE=16.4, t=1.114, p=0.7656$  and incongruent and neutral condition with shorter RT in the incongruent condition by  $16.94ms, SE=16.4, t=1.033, p=0.9054$ .

Table 4.17. Post hoc analysis for RT in L2-L1 for Sangtam-Ao Group

contrast	estimate	SE	Df	t ratio	p value
Congruent-Incongruent	-1.32	16.3	2535	-0.081	1.0000
Congruent-Neutral	-18.26	16.4	2534	-1.114	0.7656
Incongruent-Neutral	-16.94	16.4	2535	-1.033	0.9054

### Error

In the error analysis also no statistically significant difference was found between the condition,  $F(2, 201)=2.464, p=0.089$ . Table 4.18 presents Bonferroni post hoc analysis which also did not reveal any statistically significant difference between the congruent and

incongruent condition with higher RT in the congruent condition by 12.6ms,  $SE=184$ ,  $t=0.069$ ,  $p=1.00$ , congruent and neutral condition with shorter RT in the congruent condition by 301.3ms,  $SE=201$ ,  $t=1.496$ ,  $p=0.413$  and incongruent and neutral condition with shorter RT in the incongruent condition by 313.9ms,  $SE=193$ ,  $t=1.628$ ,  $p=0.3195$ .

Table 4.18. Post hoc analysis for Error RT in L2-L1 for Sangtam-Ao Group

contrast	estimate	SE	Df	t ratio	p value
Congruent-Incongruent	12.6	184	102	0.069	1.0000
Congruent-Neutral	-301.3	201	103	-1.496	0.4130
Incongruent-Neutral	-313.9	193	109	-1.628	0.3195

### Mixed Block

The data analysis of the mixed block revealed that in the congruent condition L1-L2 had higher RT ( $M=809.44$ ,  $SD=368.14$ ) than L2-L1 ( $M=779.63$ ,  $SD=362.43$ ). In the incongruent condition also L1-L2 had higher RT ( $M=818.70$ ,  $SD=369.47$ ) than L2-L1 ( $M=794.75$ ,  $SD=362.52$ ) and also in the neutral condition, L1-L2 had higher RT ( $M=812.15$ ,  $SD=358.63$ ) than L2-L1 ( $M=803.79$ ,  $SD=362.00$ ). Figure 4.18 shows the mean reaction times in both language directions across the three conditions.

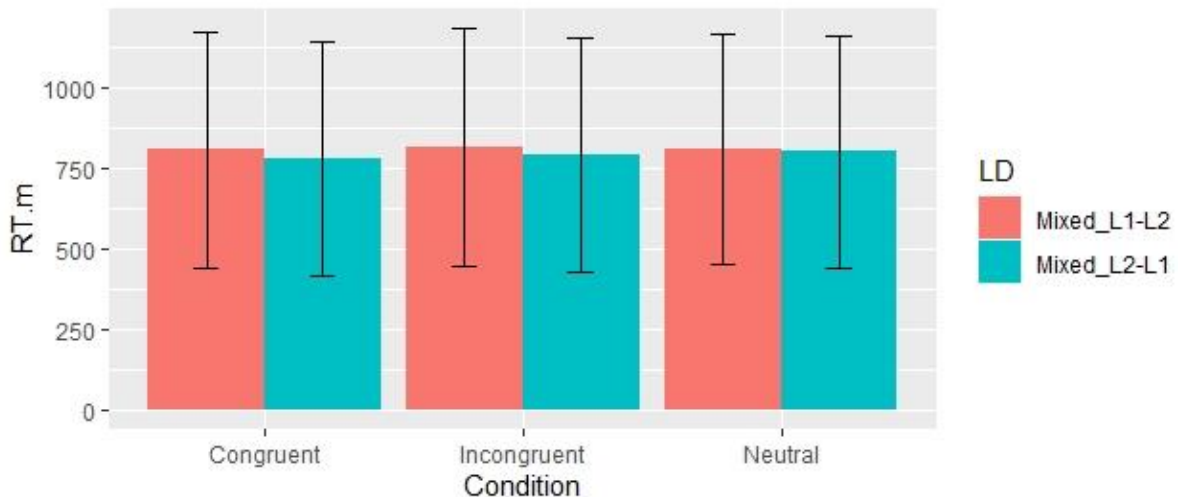


Figure 4.18. Box Plot Showing Reaction Times Across Conditions

No interaction was found between the language directions and conditions as no statistically significant difference was found,  $F(2, 7325)=0.564$ ,  $p=0.463$ . No statistically significant difference was also found between the conditions,  $F(2, 7325)=3.909$ ,  $p=0.141$ . The main

effect was found only in the language direction with statistically significant difference,  $F(1, 7325)=5.948$ ,  $p=0.006$ . Bonferroni post hoc analysis revealed statistically significant difference only between L2-L1 congruent and L1-L2 incongruent conditions with shorter RT in the L2-L1 congruent condition by  $36.44ms$ ,  $SE=11.6$ ,  $t=3.131$ ,  $p=0.0263$ .

### **Error**

In the error analysis, statistically significant difference was found only in language direction,  $F(1, 1820)=39.4561$ ,  $p<0.05$ . However no statistically significant difference was found between the conditions,  $F(2, 1820)=2.2474$ ,  $p=0.3251$  and no interaction was observed between the language directions and conditions,  $F(2, 1820)=4.4890$ ,  $p=0.1060$ . Post hoc analysis revealed that was statistically significant difference between L1-L2 and L2-L1 in the incongruent condition with higher RT in the L1-L2 direction by  $248ms$ ,  $SE=65.0$ ,  $t=3.813$ ,  $p=0.0021$  and in the neutral condition with higher RT in the L1-L2 direction by  $344ms$ ,  $SE=67.2$ ,  $t=5.125$ ,  $p<0.0001$ .

### **Discussion**

In the Sangtam-Ao group, in the single language blocks there was no statistically significant difference between the conditions, even though incongruent condition had higher RTs. In the mixed block, L1-L2 had higher RT in all the three conditions but no statistically significant difference was found. However, in the error analysis of the mixed block, L1-L2 had higher RT in all the three conditions which was statistically significant. This finding is similar to the findings in experiment 1.

#### **4.5.7.3. Combined Analysis of Ao-Sangtam and Sangtam-Ao**

Table 4.19 depicts the combined analysis of the Ao-Sangtam and Sangtam-Ao group estimated with RT as the dependent variable and group (Ao-Sangtam and Sangtam-Ao), language direction (L1-L2 vs L2-L1), condition (congruent, incongruent and neutral) and their interactions as fixed effects.

Table 4.19. Mixed effects model for RT

Variables	RTs		
	Estimate	SE	P
(Intercept)	1054.66	34.15	< .05
GroupSangtam-Ao	-112.09	48.06	0.023
LDL2-L1	-143.33	8.30	< .05
LDMixed_L1-L2	-275.83	8.20	< .05
LDMixed_L2-L1	-285.16	8.25	< .05
ConditionIncongruent	8.04	4.81	0.095
GroupSangtam-Ao:LDL2-L1	282.18	11.76	< .05
GroupSangtam-Ao:LDMixed_L1-L2	153.24	11.20	< .05
GroupSangtam-Ao:LDMixed_L2-L1	143.92	11.21	< .05

The results showed that the effect of group was significant with shorter RT in the Sangtam-Ao group by  $112.09ms$ ,  $SE=48.052$ ,  $t=2.33$ ,  $p=0.022$ . In terms of language direction, the RT was shorter by  $143.33ms$ ,  $SE=8.296$ ,  $t=17.277$ ,  $p<0.05$  which was statistically significant when the language direction went from L2-L1 as compared to L1-L2. Within L2-L1 block, Sangtam group had higher RT by  $282.18ms$ ,  $SE=11.757$ ,  $t=24.001$ ,  $p<0.05$  which was statistically significant. The mixed block had shorter RT than the single language blocks in both L1-L2 language direction by  $275.828ms$ ,  $SE=8.203$ ,  $t=33.626$ ,  $p<0.05$  and L2-L1 direction by  $285.153$ ,  $SE=8.242$ ,  $t=34.597$ ,  $p<0.05$ . Within the mixed block, Sangtam-Ao group had higher RT in both L1-L2 direction by  $153.24ms$ ,  $SE=11.192$ ,  $t=13.692$ ,  $p<0.05$  and L2-L1 direction by  $143.92ms$ ,  $SE=11.204$ ,  $t=12.846$ ,  $p<0.05$ . Although the Incongruent condition had higher RT than congruent condition by  $8.04ms$ ,  $SE=4.801$ ,  $t=1.674$  it was not statistically significant,  $p=0.094$ . Hence, the effect of the incongruent condition was not found. Figure 4.19 shows the reaction time in both the groups across condition.

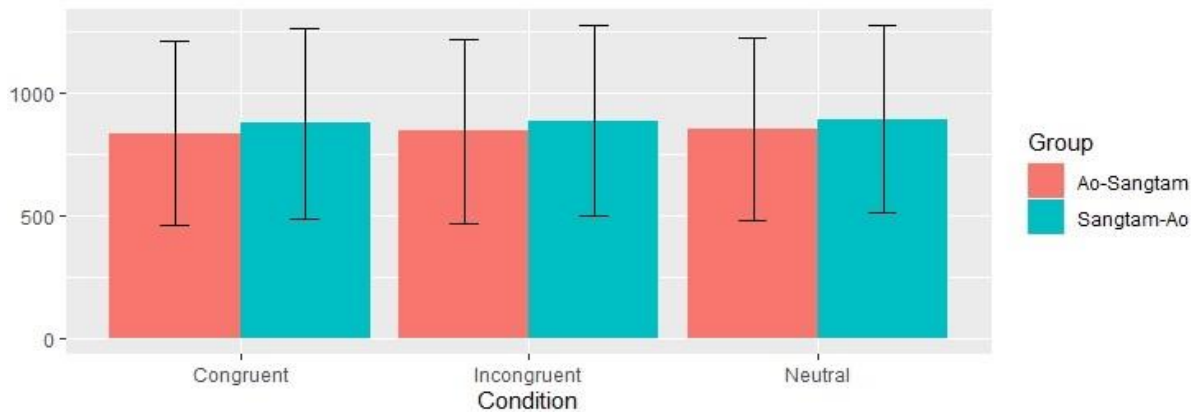


Figure 4.19. Box Plot Showing Reaction Times for both Groups Across Conditions

Figure 4.20 shows the mean reaction times for both groups across language directions in L1-L2 block, L2-L1 block and mixed block

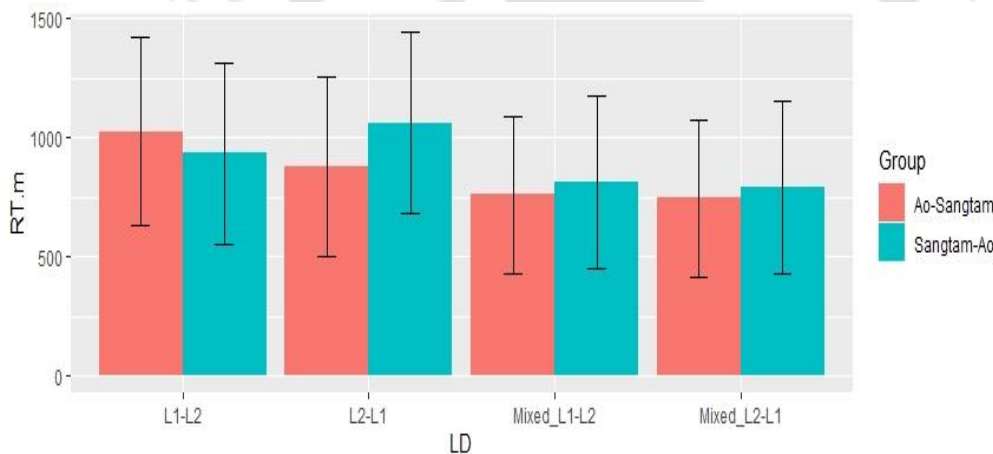


Figure 4.20. Box Plot Depicting the Mean Reaction Time for Both Groups Across Language Directions

### Error Analysis

Table 4.20 shows the fixed effects estimated of the errors with error RT as the dependent variable and group, conditions, language directions and their interactions as the fixed effects. The results revealed that Sangtam-Ao group had shorter RT than Ao-Sangtam group by  $112.071ms$ ,  $SE=9.634$ ,  $t=11.633$ ,  $p<0.05$ . Even though the incongruent condition had higher RT than congruent and neutral condition, there was no statistically significant difference,  $diff=6.112$ ,  $SE=5.620$ ,  $t=1.087$ ,  $p=0.277$ . Within the language direction, shorter RT was observed in the L2-L1 direction by  $146.881ms$ ,  $SE=9.644$ ,  $t=15.230$ ,  $p<0.05$ . Overall mixed

block had shorter RT in both L1-L2 direction by 274.911ms,  $SE=9.536$ ,  $t=28.933$ ,  $p<0.05$  and L2-L1 direction by 284.089ms,  $SE=9.592$ ,  $t=29.615$ ,  $p<0.05$ .

Table 4.20. Fixed Effects for Error RT (Combined Analysis)

	estimate	SD	P
(Intercept)	1033.316	24.812	< .05
GroupSangtam-Ao	-112.071	9.634	< .05
ConditionIncongruent	6.112	5.620	0.277
LDL2-L1	-146.881	9.644	< .05
LDMixedL1-L2	-275.911	9.536	< .05
LDMixed_L2-L1	-284.079	9.592	< .05
GroupSangtam-Ao:LDL2-L1	296.538	13.682	< .05
GroupSangtam-Ao:LDMixed_L1-L2	147.325	12.311	< .05

Note .SE = standard error

## Discussion

The findings from this experiment were similar to the findings from the first experiment. The effect of the incongruent condition was not seen and shorter RT was observed in L2-L1 direction for both the groups. Also, the experiment aimed to see the switch effect in a mixed block but it was observed that the participants responded faster in the mixed block than in the single language block. Thus, there was no switch cost. However, one thing of note is that in this experiment, the Sangtam-Ao group had shorter response latencies than the Ao-Sangtam group and lesser number of errors. Though neither of these two languages are official language in the usual sense, but underlying social reality probably is a reason. This is a hypothesis and needs clarification.

### 4.6. Experiment 3

A Flanker task was also conducted with the same Ao-Sangtam and Sangtam-Ao participants to see if similar results can be found as in the comprehension task. The aim was to shed more light on the control mechanisms used by bilinguals. Flanker task (Eriksen and Eriksen 1974) is used to assess the responses that are inappropriate in a particular task. In this task, participants are asked to indicate whether a central arrow (>) points to the right or left. This arrow is presented along with flanker arrows pointing to the same direction (congruent trials >>>>>) or different direction (incongruent trials <<<<<) than the target arrow. Responses tend to be slower for incongruent than for congruent trials, revealing the time needed to resolve the conflict between the target stimulus and the to-be-ignored flanker information. This conflict effect has been used to explore the functioning of the executive control network.

#### 4.6.1. Design

In the flanker task, the trials began with a fixation (+) which was presented on the screen for 500ms. The target stimuli were then presented on the screen for 2000ms. Inter-trial interval was for 500ms. Six stimuli were used, two congruent (>>>>>, <<<<<), two incongruent (>><<>>, <<>><<) and two neutral. The participants were asked to respond to the direction of the central arrow. If the central arrow was pointing towards the left, they had to press '1' and if it was pointing towards the right, they had to press '2'. The task was carried out with both the bilingual groups i.e., Ao-Sangtam and Sangtam-Ao bilinguals and the total number of participants was 60 (30 from each group). Figure 4.21 depicts a sample procedure of the trials.

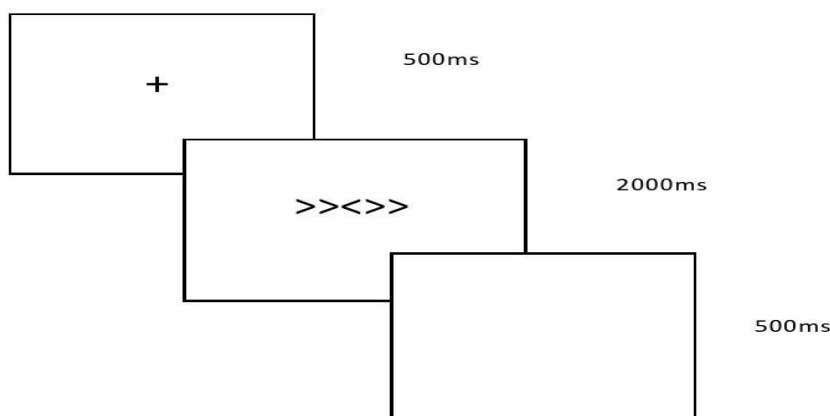


Figure 4.21. Schematic Representation of the trial procedure

**Participants: same participants as in experiment 2 took part in this experiment.**

#### 4.6.2. Results

##### Ao-Sangtam

In the analysis of the response data, incongruent condition had the highest RT ( $M=771.4908$ ,  $SD=247.75$ ) than congruent condition ( $M=715.83$ ,  $SD=208.61$ ) and neutral condition ( $M=736.85$ ,  $SD=230.23$ ). Figure 4.22 shows the mean reaction times across conditions.

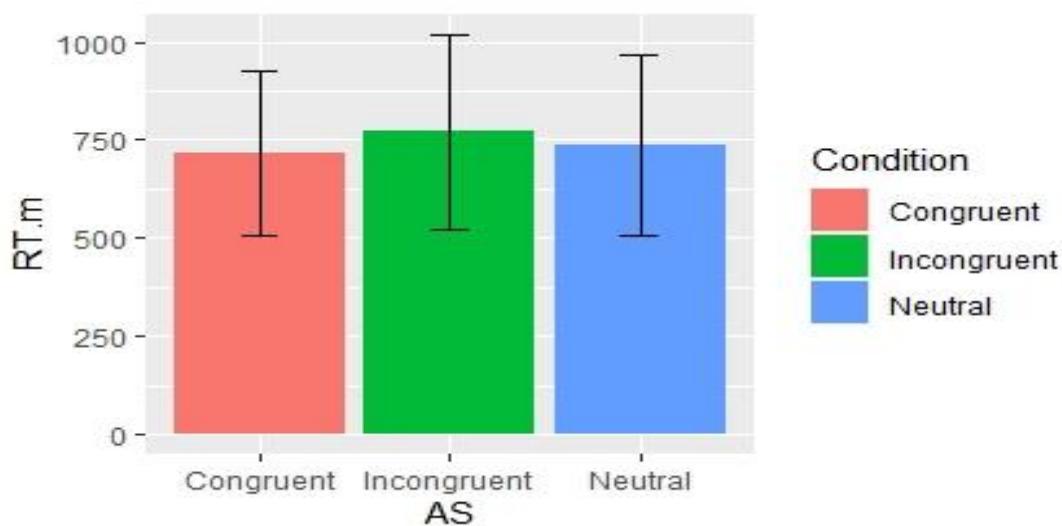


Figure 4.22. Box Plot Showing Reaction Times Across Conditions

ANOVA analysis revealed that there was a statistically significant difference between the conditions  $F(2, 2520)=12.59$ ,  $p<0.05$ . Table 4.21 presents the results of Bonferroni post hoc analysis which also revealed statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by  $60.9ms$ ,  $SE=8.80$ ,  $t=6.922$ ,  $p<0.0001$  and incongruent and neutral condition with higher RT in the incongruent condition by  $41.3ms$ ,  $SE=8.80$ ,  $t=4.688$ ,  $p<0.0001$ . There was no statistically significant difference between congruent and neutral condition with shorter RT in the congruent condition by  $19.7ms$ ,  $SE=8.80$ ,  $t=4.688$   $p=0.0683$ .

Table 4.21. Post hoc analysis for RT

contrast	estimate	SE	df	t ratio	p value
Congruent-Incongruent	-60.9	8.80	2520	-6.922	<.0001
Congruent-Neutral	-19.7	8.63	2519	-2.279	0.0683
Incongruent-Neutral	41.3	8.80	2520	4.688	<.0001

### Error Analysis

Error data analysis revealed that there was no statistically significant difference between the conditions,  $F(2, 146)=2.7883$ ,  $p=0.248$ . Table 4.22 presents Bonferroni post hoc analysis which also did not show any statistically significant difference between the congruent and incongruent conditions with shorter RT in the congruent condition by  $157ms$ ,  $SE=98.5$ ,  $t=1.593$ ,  $p=0.3397$ , congruent and neutral condition with shorter RT in congruent condition by  $59.9ms$ ,  $SE=110.1$ ,  $t=0.545$ ,  $p=1.00$  and incongruent and neutral condition with higher RT in the incongruent condition by  $97ms$ ,  $SE=101.4$ ,  $t=0.957$ ,  $p=1.00$ .

Table 4.22. Post hoc analysis for RT

contrast	estimate	SE	df	t ratio	p value
Congruent-Incongruent	-157.0	98.5	146	-1.593	0.3397
Congruent-Neutral	-59.9	110.1	140	-0.545	1.0000
Incongruent-Neutral	97.0	101.4	144	0.957	1.0000

### Discussion

The data analysis of the Ao-Sangtam group in the flanker task revealed that the participants showed the flanker effect as the participants incurred higher reaction times in the incongruent condition as compared to the congruent and neutral condition and there was also statistically significantly difference.

## Sangtam-Ao

The response data analysis revealed that incongruent condition had the highest RT ( $M=764.16$ ,  $SD=208.41$ ) than congruent ( $M=712.03$ ,  $SD=190.71$ ) and neutral ( $M=721.35$ ,  $SD=205.33$ ) conditions. Figure 4.23 shows the mean reaction times of all the three conditions.

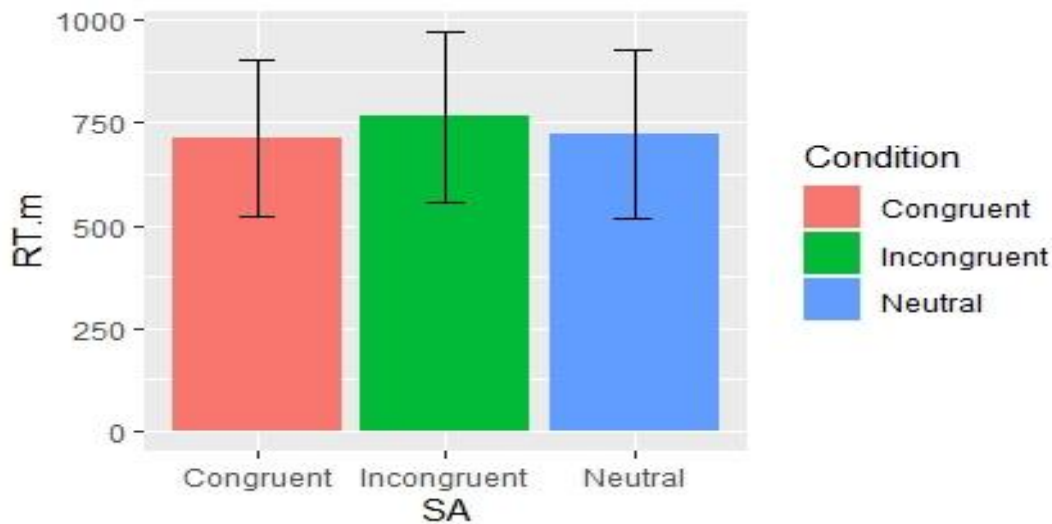


Figure 4.23. Box Plot Showing Reaction Times Across Conditions

ANOVA analysis revealed that there was statistically significant difference between the conditions,  $F(2, 2593)=16.58$ ,  $p<0.05$ . Table 4.23 presents the results from Bonferroni post hoc analysis which showed that there was statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by  $50.1ms$ ,  $SE=8.17$ ,  $t=6.132$ ,  $p<0.0001$  and incongruent and neutral condition with higher RT in the incongruent condition by  $41.6ms$ ,  $SE=8.18$ ,  $t=5.088$ ,  $p<0.0001$ . However, there was no statistically significant difference between congruent and neutral condition with shorter RT in the congruent condition by  $8.5ms$ ,  $SE=8.15$ ,  $t=1.042$ ,  $p=0.8920$ .

Table 4.23. Post hoc analysis of RT for Sangtam-Ao

contrast	estimate	SE	df	t ratio	p value
Congruent-Incongruent	-50.1	8.17	2593	-6.132	<.0001
Congruent-Neutral	-8.5	8.15	2593	-1.042	0.8920
Incongruent-Neutral	41.6	8.18	2593	5.088	<.0001

## Error

In the error analysis, no main effect of the conditions was found between the conditions as there was no statistically significant difference,  $F(2, 68)=1.0029$ ,  $p=0.133$ . Table 4.24 presents Bonferroni post hoc analysis which also did not show any statistically significant difference between the congruent and incongruent conditions with higher RT in the congruent condition by  $18.1ms$ ,  $SE=92.5$ ,  $t=0.195$ ,  $p=1.00$ , congruent and neutral conditions with higher RT in the congruent condition by  $89.1ms$ ,  $SE=96.9$ ,  $t=0.919$ ,  $p=1.00$  and incongruent and neutral condition with higher RT in incongruent condition by  $71.0ms$ ,  $SE=90.2$ ,  $t=0.788$ ,  $p=1.00$ .

Table 4.24. Post hoc analysis of Error RT for Sangtam-Ao

	estimate	SE	df	t ratio	p value
Congruent-Incongruent	18.1	92.5	64.2	0.195	1.0000
Congruent-Neutral	89.1	96.9	63.8	0.919	1.0000
Incongruent-Neutral	71.0	90.2	65.6	0.788	1.0000

## Discussion

The results of the Sangtam-Ao analysis were similar to the Ao-Sangtam results. The participants showed the effect of incongruent condition as the incongruent condition had higher RT as compared to the congruent and neutral condition and it was also statistically significant difference.

## Combined Analysis of the Two Groups

Figure 4.24 shows the comparison of mean reaction times for the two groups across conditions.

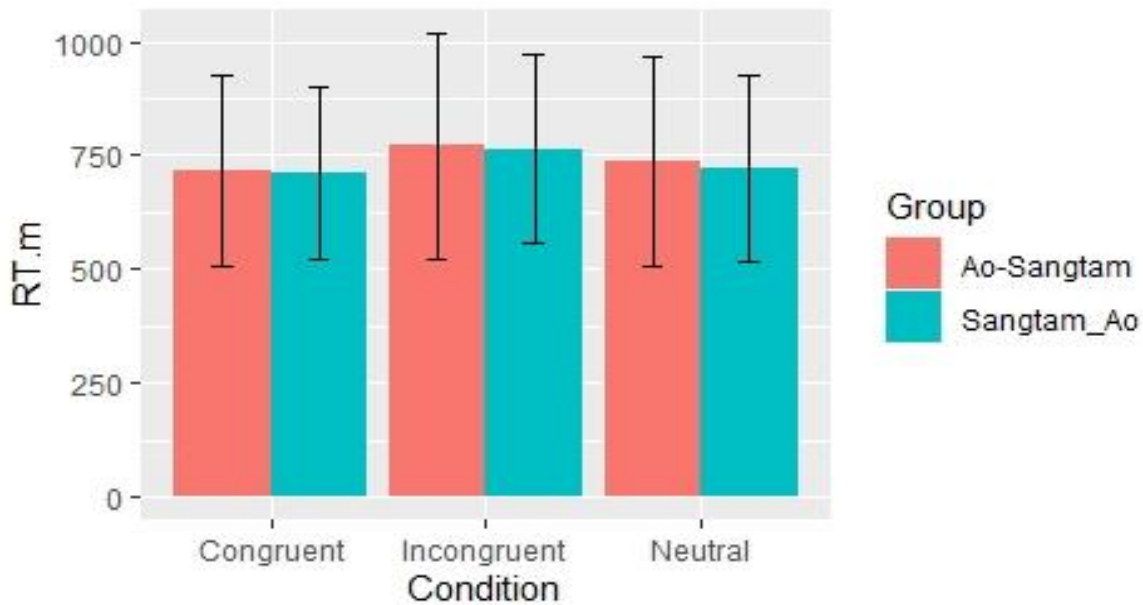


Figure 4.24. Box Plot Showing RTs Across Condition in Both Groups

Table 4.25 shows the Fixed effects estimated with fully parameterized linear mixed model (LMM) with RT as the dependent variable and group, condition and their interactions as the fixed effects. The results showed that the incongruent condition had higher RT than the congruent and neutral condition by 71.69ms,  $SE=58.37$ ,  $p=0.0001$ , which was statistically significant as shown by the p value. However, there was no difference between the groups with respect to the incongruent condition.

Table 4.25. Mixed effects model for RT

Note, SE=Standard Error

Variable	estimate	SE	p
Fixed effects			
Intercept	741	58.37	<2e-16***
ConditionIncongruent	71.69	19.10	0.000177
ConditionNeutral	30.85	18.79	0.100769
Group	-18.48	36.91	0.618347
ConditionIncongruent:Group	-10.79	12.00	0.368570
ConditionNeutral:Group	-11.18	11.87	0.346182

## Error Analysis

Table 4.26 depicts the fixed effects estimated with fully parameterized linear mixed model (LMM) for errors with RT as the dependent variable and groups, condition and their interactions as the fixed effects. Even though the incongruent condition had higher RT than congruent and neutral condition by 255.61ms,  $SE=216.38$ ,  $p=0.23$ , it was not significant as shown by the p value. The main effect of the group was also not seen from the analysis.

Table 4.26. Mixed Effects Model for error RT

Note, SE=Standard Error

Fixed effects	estimate	SE	p.value
(Intercept)	628.51	234.44	0.00917***
ConditionIncongruent	255.61	216.38	0.23878
ConditionNeutral	184.76	238.77	0.43993
Group	-16.39	159.80	0.91857
ConditionIncongruent:Group	-106.94	150.29	0.47751
ConditionNeutral:Group	-126.20	162.39	0.43796

## Discussion

The experiment examined the effect of flanker on response latencies in Ao-Sangtam and Sangtam-Ao group. Both the groups showed the effect of the incongruent flanker suggesting that even though our participants are high proficient bilinguals, they took longer time to resolve the conflict. These participants were the same group of participants that took part in experiment 3 (culture cue comprehension task). In the comprehension task, the participants did not show the effect of the incongruent cue. This could suggest that maybe not all bilinguals react/perform the same way in all experiments/tasks. Different bilinguals with different experiences might play a role in the processing strategies applied by the speakers.

### 4.7. Experiment 4

Bilinguals often speak two languages with different status, where one of the languages is dominant. This can be due to the relative status of the language and/or by virtue of being the majority language. In India, for example, in case of Hindi-English bilinguals, English is the second language and the more prestigious one. English as a second language has specific

connotations. A high proficient bilingual whose second language is English is almost certainly at a higher plane in terms of socio-economic-educational and occupational achievements. Naturally, when looking at a high proficient English language speaker under experimental set up, we are also looking at someone with accomplishments not many people without that proficiency have, putting him at an advantageous position already. One may argue that the higher executive control thus derived from such a person under any task condition is not entirely due to his/her bilingual proficiency per se but due to factors co-occurring with higher proficiency in English. One can then compare the results from English speaking (as a second language) subjects for a possible pointer in this regard. Similarly important is how the second language is learnt. English in India is always learnt through formal training.

This was a lexical decision task and the participants were Ao-English bilinguals who are university students and do not live in their native place. They are scattered across the country in different universities. All the participants are L1 Ao speakers belonging to the Ao tribe but they are all students pursuing different courses in different universities across India. Since they are living away from their native place and immersed in a student environment, they often use English more than their L1 (Ao). Thus, in such an environment, English becomes their primary language and not Ao.

#### **4.7.1. Design and Stimuli**

The experiment was divided into two parts, Ao block and English block. For each block, 20 words and 20 non-words were chosen after they were rated on a scale of 1-10 by participants who did not take part in the main experiment. For the stimulus, we used culturally iconic food items of both Ao and English (2 each) as the prime. For instance, we used the images of a burger or fried chicken which people associate with the western world and thus represents the western culture (and English language) and for L1 cue, traditional Ao Naga food items were chosen. These images were presented in the background. There were three conditions, congruent, when the image matched the target word, incongruent, when there was a mismatch between the image and the target word and neutral condition. For the neutral condition, we kept the background blank. The participants were administered an L2 proficiency test (Lextale, Lemhofer and Broersma, 2012) and the average score was 89.62 % with a standard deviation of 5.81% . They also completed a language history questionnaire where they gave self-ratings on L1 and L2 proficiency as well as acquisition and language preference/usage in

various domains like home, social settings, educational institutions etc. This data is presented in Table 4.27. Figure 4.25 depicts a sample trial of the experiment. The experiment was designed on E Prime 3.

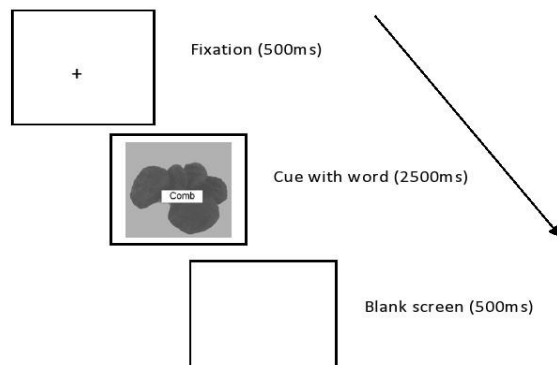


Figure 4.25. A Sample Trial

#### 4.7.2. Procedure

The data for this experiment was collected during the covid-19 pandemic and physical collection of data was not possible; so E-prime Go was used which enables remote data collection. The participants were sent link to the experiments along with instruction on how to proceed with the experiment. The participants downloaded the experiment through the links and ran it on their own systems and their data was uploaded automatically to our E Prime account at the completion of the experiment.

#### 4.7.3. Participants

In this study, 20 Ao-English participants took part in this lexical decision task (LDT). The participants were L1 speakers of Ao and were all students from different universities in Guwahati, Hyderabad, Delhi and Mumbai. They ranged in age from 21-30 years. The participants gave informed consent to participate in the study. Before the experiment proper, the participants filled out a questionnaire in which they gave self-report ratings (scale of 1-7) on the AoA and proficiency of both the languages. Table 4.27 shows the self-report ratings given by the participants on the Age of Acquisition (AoA) and proficiency in both the languages.

Table 4.27. Self-report Rating on AoA and Proficiency

	Mean	SD
Acquisition		
L1	1.5	0.80
L2	4	1.37
Self-report proficiency rating L1		
Listening	6.25	0.82
Speaking	5.9	0.94
Reading	5.55	0.86
Writing	4.6	1.01
Self-report proficiency rating in L2		
Listening	5.95	0.80
Speaking	5.3	0.9
Reading	5.95	
Writing	5.35	1.01

From the table, we can see that the AoA for L1 starts from infancy, whereas for L2 it coincides with the start of formal education. As for the proficiency, the participants gave similar ratings on listening, speaking and reading. In terms of writing, we can see that L2 had a higher rating and this could be because, L1 is not learned in a formal set up for most speakers of this community with English medium schools as the preferred kind of education for most parents.

#### 4.7.4. Results

##### 4.7.4.1. Ao Block

In the correct response data analysis, the effect of the incongruent condition was seen with higher RT in the incongruent condition ( $M=1024.37$ ,  $SD=291.24$ ) than the congruent ( $M=979.30$ ,  $SD=284.46$ ) and neutral condition ( $M=957.74$ ,  $SD=292.97$ ). Figure 4.26 shows the mean reaction times of the conditions in Ao block.

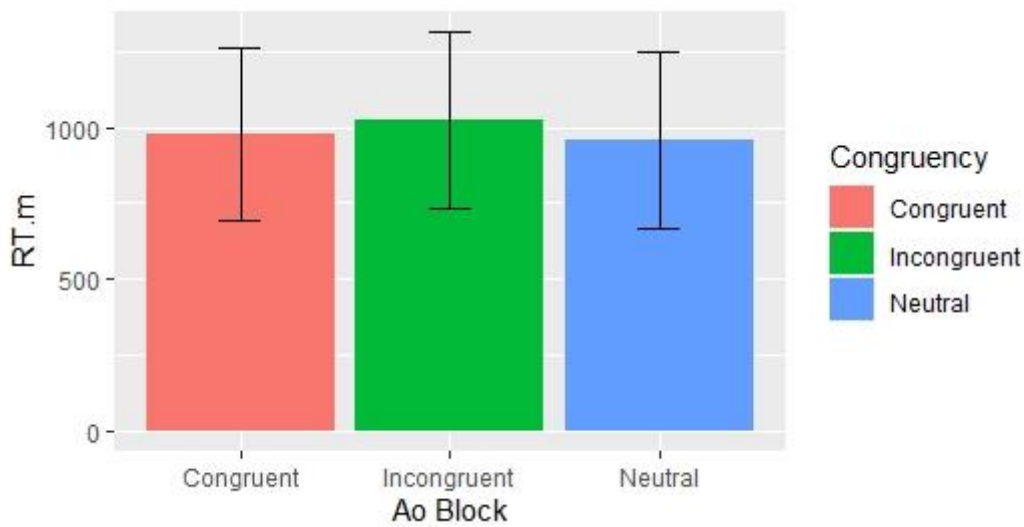


Figure 4.26. Box Plot of Mean Reaction Times Across Conditions

ANOVA analysis revealed that there was statistically significant difference between the conditions,  $F(2, 1940)=8.961, p<0.05$ . Further, Bonferroni post hoc analysis depicted in table 4.28 revealed that there was statistically significant difference between the congruent and incongruent condition with shorter RT in the congruent condition by  $42.1ms, SE=14.3, t=2.952, p=0.0096$  and incongruent and neutral condition with higher RT in the incongruent condition by  $66.9ms, SE=14.3, t=4.688, p<0.001$ . There was no statistically significant difference between congruent and neutral conditions with higher RT in the congruent condition by  $24.8ms, SE=14.2, t=1.747, p=0.2423$ .

Table 4.28. Post hoc analysis for RT

contrast	estimate	SE	df	t ratio	p.value
Congruent-Incongruent	-42.1	14.3	1940	-2.952	0.0096
Congruent - Neutral	24.8	14.2	1940	1.747	0.2423
Incongruent - Neutral	66.9	14.3	1940	4.688	<.0001

#### 4.7.4.2. English Block

In the English block also, participants exhibited the highest RT in the incongruent condition ( $M=897.11$ ,  $SD=281.51$ ) followed by the congruent condition ( $M=877.83$ ,  $SD=271.14$ ). Lowest RT was observed in the neutral condition ( $M=853.95$ ,  $SD=278.69$ ). Figure 4.27 shows the mean reaction times across the three conditions.

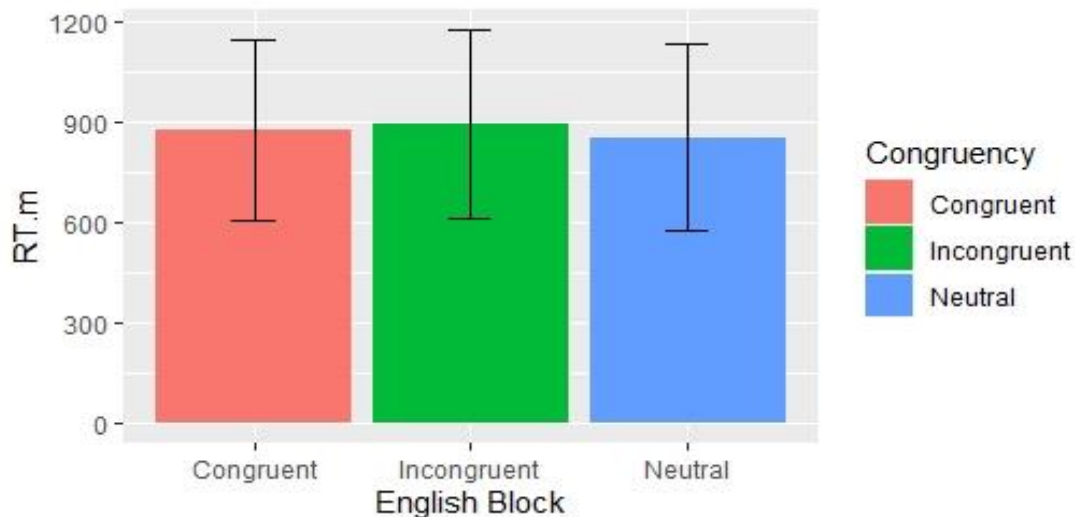


Figure 4.27: Mean Reaction Times Across Conditions

ANOVA analysis revealed that there was main effect of condition with statistically significant difference between the conditions,  $F(2, 4067)=8.268$ ,  $p<0.05$ . Further post hoc analysis as depicted in Table 4.29 revealed that there was statistically significant difference between the congruent and neutral condition with higher RT in the congruent condition by  $25.7ms$ ,  $SE=9.70$ ,  $t=2.652$ ,  $p=0.0241$  and incongruent and neutral condition with higher RT in the incongruent condition by  $43.8ms$ ,  $SE=9.73$ ,  $t=4.499$ ,  $p<0.0001$ . However, there was no statistically significant difference between congruent and incongruent condition even though shorter RT was observed in the congruent condition by  $18ms$ ,  $SE=9.71$ ,  $t=-1.858$ ,  $p=0.1895$ .

Table 4.29. Post hoc analysis for RT for Ao Block

contrast	estimate	SE	df	t ratio	P value
Congruent	- 18.0	9.71	4067	-1.858	0.1895
Incongruent					
Congruent - Neutral	25.7	9.70	4067	2.652	0.0241
Incongruent - Neutral	43.8	9.73	4067	4.499	<.0001

#### 4.7.4.3. Combined Analysis

Table 4.30 presents the fixed effects estimated with fully parameterized linear mixed model (LMM) with RT as the dependent variable and language, condition and their interactions as the fixed effects. The results show that overall English block had shorter RT than the Ao block by  $195.95ms$ ,  $SE=12.435$ ,  $p<0.05$ . This means that the participants performed better in the English block than the Ao block. The effect of the incongruent condition was found in both the blocks with a higher RT than the congruent and neutral condition  $42.036ms$ ,  $SE=12.745$ , it was statistically significant,  $p=0.000981$ . Within the incongruent condition, the RT was shorter in the English block as compared to the Ao block by  $44.411ms$ ,  $SE=17.645$  which was statistically significant,  $p=0.012$ . This means that the presence of the English iconic picture had more effect on Ao word recognition than vice versa. Figure 4.28 shows the mean reaction times of the two blocks across conditions.

Table 4.30. Mixed Effects Model for RT

Note. SE = standard error

Fixed effects	estimate	SE	P
(Intercept)	978.280	27.399	<.002
LanguageEnglish	-195.953	12.435	<.002
CongruencyIncongruent	42.036	12.745	0.0009
LanguageEnglish:CongruentIncongruent	-44.411	17.645	0.012

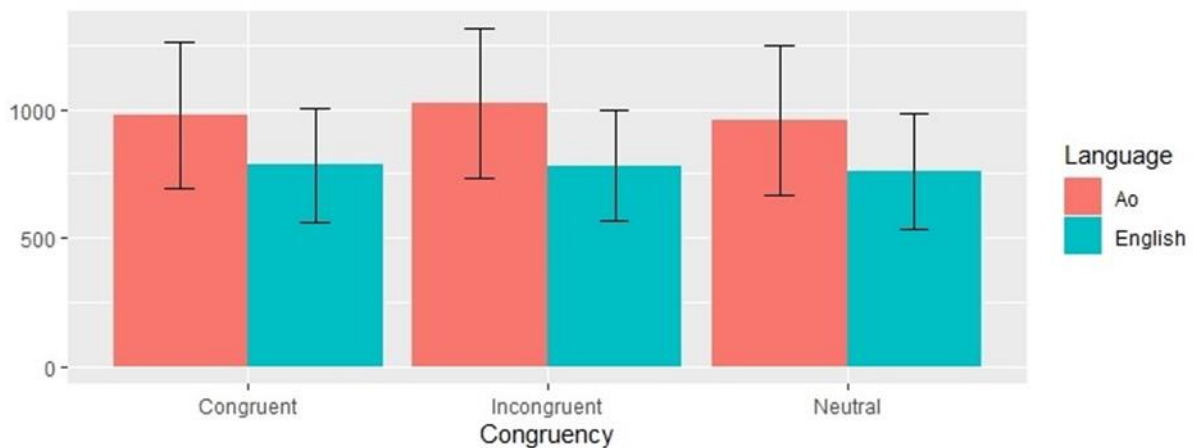


Figure 4.28. Box Plot Showing the Mean RTs of the Two Groups Across Condition

### Error Analysis

Table 4.31 shows the fixed effects estimated with fully parameterized linear mixed model (LMM) with RT as the dependent variable and group, condition and their interactions and the fixed effects. The effect of the group was not seen in the error analysis. Overall, incongruent condition had higher RT than congruent and neutral condition by  $240.17ms$ ,  $SE=129.42$ ,  $p=0.064$ , but it was not statistically significant as indicated by the p value.

Table 4.31. Mixed Effects Model for error RT

Note. SE = standard error

Fixed effects	estimate	Std. Error	p.value
(Intercept)	782.03	109.34	1.22e-11 ***
Group	29.07	69.21	0.675
ConditionIncongruent	240.17	129.42	0.064
ConditionNeutral	32.65	131.35	0.804

The participants incurred higher number of errors in the Ao block as compared to English block in all the three conditions (Congruent: Ao=15.25%, English=7.75%; Incongruent: Ao=17.87% English=9.12%; Neutral: Ao=16.25% English=10%). The higher errors in the Ao block could suggest that the presence of the L2 image led to interference in L1 recognition. Error analysis showed that there was no statistically significant difference

between the groups,  $p=0.675$  and the effect of the incongruent condition was also not seen,  $p=0.064$ .

## **Discussion**

The results from this experiment shows that the Ao-English bilinguals were sensitive to the presence of culture cue. Overall higher RT was observed in the case of L1 block as compared to L2 block across all three conditions. This indicates that there was interference by L2 images in L1 processing. The participants in this study were students from universities living in places where the predominant language for communication is English. Thus, the participants were high proficient English speakers and moreover, they live outside of the state in which their L1, Ao is spoken. Hence, L2 becomes more dominant in this case. Thus, there was interference of L2 in L1 processing but such a case was not seen when it came to the presence of L1 in L2 processing. The image used was presented only at the background but still it had an impact and there was statistically significant difference in the incongruent condition as compared to congruent condition and statistically significant difference was seen on the interaction between language and condition on RT. The presence of the L2 significant image led to interference in L1 processing and thus led to inhibition of L1 in the presence of L2 culturally significant image.

Our finding is in line with our hypothesis that bilinguals whose two languages and cultures are significantly apart will display more effect of cultural images. In the previous experiments no significant impact of the presence of cultural cues on the bilingual language processing was found, which is different from the literature available today. Here, we argue that culturally distant bilinguals like Chinese-English or even Hindi-English bilinguals will exhibit more interference by the presence of cultural cues. The participants in the previous two studies were bilinguals who lived side by side and interact with each other on a daily basis and they switch between the two languages frequently. Hence, there is a fluidity in the switching between the two languages as well as the culture. In a place like Northeast India or Nagaland, where various languages are spoken by different groups of people in a small geographical area, the interaction of culture as well as language becomes more evident and prominent which is different from Chinese-English bilinguals where the bilinguals have immigrated to a different country and are immersed in that culture and language because of various reasons. The findings from the LDT experiment on university students also points towards the importance of language dominance and social environment. In this study, since

the participants were all university students living in university campuses, their language usage pattern was predominantly English which is their L2. Also, they were far away from their home state and immersed in an academic environment. Hence, the effect of condition on L1 processing was seen.

#### **4.8. Findings and Observations from the Four Experiments**

In this chapter, we tried to look at the effect of extra-linguistic cues in word recognition experiments with focus groups that are heritage language speakers. The participants in all the experiments live in an essentially multicultural social set up, with socially fluid relations with each other. In the first experiment, the Rongmei-Meitei speakers had a complicated relationship with the language (Meitei) as well as socio-political and cultural differences. Hence despite living in close proximity with each other, the differences were still prevalent. In this experiment, we also looked at the effect of age within the Rongmei bilinguals by taking older and younger generation in the same experiment. In the second experiment, the groups Ao and Sangtam are unique from language use perspective as both the groups speak each other's language fluently and reside in the same community for decades. Hence, in this group, cultural exchange happens frequently and organically. The third groups of bilinguals were Ao-English bilinguals. These bilinguals are different from the first two in the sense that they are university students living far from their native place. Thus, comparing this group with the other two groups of bilinguals was aimed at finding out if the second language's status has a role to play in the outcome of the experiments. And if the cultural distance and proximity have any influence on the results.

The results from the experiments points towards few things which could help us shed more light towards the above mentioned points. Firstly, the effect of the incongruent condition was found only in the Ao-English experiment. Such an effect was found neither in the Rongmei-Meitei or the Ao-Sangtam study. This finding is very interesting and differs from current literature on the effects of culture cue on bilingual language processing. In the first two experiments, the participants did not show the effect of the incongruent condition. This means that the presence of the culture cue had no effect on the processing in comprehension task in the first two experiments. But this effect was found in the Ao-English study. The participants incurred higher RT in the Ao block as compared to the English block. This means that the presence of English iconic picture had an effect on Ao in comprehension. This

finding sheds light on the importance of cultural distance and proximity. In the Rongmei-Meitei and Ao-Sangtam experiments, since the communities under study were living in close proximity with each other and even bicultural in the case of the Ao-Sangtam study, the participants did not regard the other culture as something different or ‘foreign’. Also, these two groups have been living side by side for decades and have shared their cultures, traditions and languages and this might have played a role. Also, the two groups in our study are highly proficient bilinguals who use both the languages on a daily basis. Thus, the type of bilingualism and usage might also have played a part in the results. But in the Ao-English study, English language is a language that is held in a higher status and esteem as compared to Ao, as is the case for most languages in India or in most parts of the world. The culture associated with the English language i.e., United States or United Kingdom is also very different from that of the Ao culture. The participants performed better in the English block as compared to the Ao block and the effect of the incongruent condition was also more in Ao block which shows that the presence of the L2 culturally significant image had an impact in L1 recognition. This might be the result of an English dominant environment as is common with university student pool. Even though the participants were university educated high proficient L2 speakers, the effect of the incongruent cue was still seen. This is in line with previous findings where cultural and linguistic distance resulted in interference of L1 recognition or production in the presence of L2 cultural icon. In the Rongmei-Meitei and Ao-Sangtam experiment, the two languages and cultures studied/examined were closely related and hence we did not see the effect of the culture cue. However, in the Ao-English study because of the distance in the culture as well as the languages, interference of the L2 image was observed on L1 processing. The environment in which the participants were living is also worth noting. The participants in the first two experiments live in places where both L1 and L2 are used in day-to-day life and switching happens very frequently. The participants in this study could belong to the Dual Language Switching Context (DLC) of the Adaptive Control Hypothesis (Green and Abutalebi, 2013) (we did not explicitly collect this information, though). According to this hypothesis, the DLC bilinguals are constantly switching from one language to another and hence exhibit enhanced cognitive control. This might be the reason why no switch cost was seen either. However, the participants in the Ao-English experiment are bilinguals living far from their native culture and language in universities speaking mostly English. And thus, the usage of L1 becomes less and L2 becomes dominant. Also, they are not exposed to their native culture in such environments. From the analysis of the results, we can see that in the Rongmei-Meitei and Ao-Sangtam study, no or very little evidence of the

effect of the cultural cue in the incongruent condition. However, in the Ao-English study, the greater delay in response time in the Ao block shows that the presence of L2 specific image resulted in interference. The results point towards the importance of taking into account the type of bilingualism practised in different social settings. Ao-Sangtam participants were from Nagaland in Northeast India who practised a fluid bicultural and bilingual environment for decades whereas the Ao-English participants (though originally from Nagaland) were university students studying in different parts of India where English is predominantly spoken. Hence, the type of bilingualism practised by the participants can be said to be responsible for the different outcomes. Overall, the present study shows that the bilingual experience is an important factor in bilingual language processing. More work among such groups is warranted.

Secondly, a common thing that was observed in Rongmei-Meitei and Ao-sangtam study was that in both experiments, the participants showed shorter RT in L2-L1 direction as compared to L1-L2 which is in line with previous studies and confirms the prediction that translation from L2 to L1 is generally easier. Also the prediction that L1 activation may suffer less interference by the L2 than vice versa (Kroll et al., 2006) is confirmed by these findings. The results from the two studies are consistent with similar findings from production studies where L2 has been found to be more affected by mismatch culture cue/interlocutor.

Thirdly, in the Ao-Sangtam study, switch cost was also examined. In the experiment, there were two groups of bilinguals, Ao-Sangtam and Sangtam-Ao. In both the groups the mixed block had shorter RT in both language directions which were statistically significant. This means that the participants did not suffer any switch cost. This finding is in line with many others' that shows that shifting language may not always be more difficult than staying in one language. Absent switch cost is typical to bilingual comprehension, and not to production. The experiment was not a case of typical language-switch as the direction of translation was switched rather than one language that needs to be comprehended. Nonetheless, absent switch cost was observed, or rather a switch benefit, even when same manual response had to be given. One thing to be noted here is that the Sangtam-Ao group had higher RTs in the L2-L1 direction in the single language block and in both the language directions in the mixed block. This means that overall, the Ao-Sangtam group performed better than the Sangtam-Ao group. Such a result could be due to various reasons but one important and crucial factor could be the social relations between the two communities. The Ao community had and still have a strong influence in the region. And hence the Sangtam-Ao group has a more respectable

attitude towards the Ao language than the Ao-Sangtam group towards the Sangtam language. And though we did not see the effect of the incongruent condition from our results, the presence of the culture cue might have had some sort of interference resulting in delayed response.

#### **4.9. Conclusion**

This chapter focussed on bilinguals with different socio-cultural backgrounds and its impact on language processing and control patterns. The findings suggests that the background and 'bilingual' experience play a huge role and these factors could be the key to finding more about bilingualism and the different mechanisms associated with it. The findings from the experiments differs from existing literature in some cases and thus points towards the importance of looking at the types of bilingualism and bilinguals. The findings from our experiments with non-WEIRD bilinguals points towards a different perspective of looking at bilingual language processing. Speakers who live in a community where bi/multilingualism is a norm may be better at conflict monitoring than those of immigrant population from western countries. After all, for these participants, English has been given importance ever since they landed in the country that they have settled and they are constantly told to suppress their L1 and culture for various socio-economic reasons. For them suppressing their L1 is the norm so it's no wonder that we get results of L1 suppression in the presence of L2 cultural/ iconic image. Evidence of this can be seen from our experiments. The participants from the Rongmei-meitei and Ao-sangtam experiments were speakers who live in the community where both the languages are spoken and the cultures practised. However, the participants from the Ao-English experiment were speakers of Ao languages who were living in university environments where the practise of their culture is non-existent and their L1 hardly spoken. For such bilinguals, the L2 becomes more dominant. These participants are like the immigrant population in the western countries and so we got similar results. Therefore, it's not only the culture cues but also the environmental background of the bilinguals that plays a huge role here.

The experiments in this chapter thus show that for bilinguals whose socio-cultural environment demands an active participation in language switching on a daily basis might exhibit a different pattern in language processing as compared to immigrant bilinguals or bilinguals whose cultures are farther apart. In places like India where bilingualism is a norm and not an exception, bilinguals have to deal with more than two languages and cultures

simultaneously, they might be more adapt to ignore irrelevant cues and focus on the target language. This could suggest higher executive control and point towards evidence for Adaptive Control Hypothesis (Green & Abutalebi, 2013) in a larger sense.

The studies reported in this chapter is but a beginning in the direction of understanding bilingual (or bi/multicultural) advantage taking into some factors that are only beginning to get attention, namely use of indigenous languages, non-immigrant, non-WEIRD population. Finer nuances of the process can only be understood after adequate amount of data has been generated through many more such studies (van der Noort et al., 2019). More studies involving bi/multilingual societies speaking a number of local languages need to be carried out with large number of participants, using different task conditions to get a better picture in this regard.



## CHAPTER 5: LANGUAGE CONTEXT



## 5.1. Introduction

In the background of the importance of bilingual context in language processing, the previous chapter investigated the role of cultural context, in terms of larger social background of the speakers. The studies thereof dealt with subtle variations of the inter-group relationships, status of the relevant languages, impact of age/occupation, distance between the languages and cultures and so on. The other type of contextual information that seems to have a close connection with language processing strategies is that of interactional context, or more precisely the language switching context of the participants.

In a bicultural and bilingual society, bilinguals have to switch from one language to another depending on the person with whom they are interacting. This is the linguistic context (interactional context) of a bilingual and the ability to constantly monitor their two languages and produce and understand the two languages demands an excessive amount of control. This demand for control is higher than the demand on a monolingual. This demand on linguistic control can also lead to overall enhanced executive control (Prior & Gollan, 2011; Verreyt et al., 2016; Hartanto & Yang, 2016). In this regard, the Adaptive Control Hypothesis (Green & Abutalebi, 2013) is among the most prominent theoretical accounts linking this type of background information with language and executive control. The hypothesis proposes three interactional contexts, reflecting everyday interactional scenario, to showcase the different demands they place on the control processes. The three contexts are: single language context, dual language context and dense code-switching context. The single language context (SLC) in which the two languages are used separately (e.g., one language at home and the other at work), dual language context (DLC) in which the bilinguals use both languages in the same context but with different speakers. Switching happens in this context in the conversation but not within an utterance. The third context is the dense code switching context in which the bilingual intermixes the two languages in the same context and adapt words from both the languages to the context of the other. Switching happens in a single utterance in this context and bilinguals can freely switch between languages and can use an opportunistic planning approach using words that are most easily available regardless of the language. Thus, this type of switching may require relatively little cognitive control. These interactional contexts exert different types of demand on the control processes. The SLC is argued to demand cognitive processes such as goal maintenance and ongoing inhibition of the non-target language. Since language switching takes place very frequently in the DLC, it requires various control processes including conflict monitoring, interference suppression, selective

response inhibition, and task. And in the third context, since bilinguals freely switch between languages, without affecting the conversation, it may require relatively little cognitive control. In the SLC and DLC, conflict must be resolved in order to avoid interference from the non-target language. DLC speakers are faced with a control dilemma as both the languages are active and constantly compete for selection. On the other hand, opportunistic planning is higher in dense code-switching context. In the SLC, speakers avoid non-target language intrusion and try to maintain one language in a particular context. Thus, all the three interactional context demands different kinds of control mechanisms and the bilinguals adapt to these demands.

Language use in bilingual speakers increases the demand on the processes involved in utterance selection over and above those that are imposed on monolingual speakers. If control processes adapt to such demands, then this argument provides a basis for expecting possible advantages in the cognitive control of nonverbal tasks though it leaves open the mechanism involved. Comprehension processes in bilingual speakers are relevant to the adaptive response. They may tune the system to detect critical features that discriminate one language from another (Krizman et al., 2012; Kuipers & Thierry, 2010) and adapt processes that control interference between competing word meanings (Macizo, Bajo, & Martin, 2010). The adaptive control hypothesis suggests that bilinguals' interactional context is a key factor that modulates cognitive advantages in Executive Function. Hartanto & Yang 2016 found that bilinguals who mainly engage in a dual-language context showed smaller switch costs than those who mainly engage in a single-language context. Moreover, Guerrero et al., 2015 found that bilingual children who spoke a more balanced mixture of languages at home (e.g., 50% English and 50% another language) displayed lower switching costs in a trail-making task than those who spoke only one language at home. Verhagen et al., 2015 also reported that bilingual children whose parents spoke different languages performed significantly better on the Stroop and delay-of-gratification tasks than bilinguals whose parents spoke the same language as the child. It is clear, therefore, that the interactional context of bilinguals' conversational exchanges is a critical factor that renders bilingual experience more advantageous in shifting Executive Function (EF) and, in turn, enhances task-switching performance. Language-switching frequency has also been found to modulate inhibitory control, which is closely related to task switching (Friedman et al., 2006; Miyake & Friedman, 2012).

Researchers have found support for the adaptive control hypothesis in interleaved picture-word comprehension and Flanker task from Chinese-English bilinguals (Jiao et al., 2019), in language switching task with English-Mandarin bilinguals (Lai & O'Brien, 2020). It was also reported that bilinguals with balanced usage of both the languages showed lower switch cost in trial-making task than bilinguals who spoke only one language at home (Guerrero et al., 2015). A similar kind of result was also reported from Stroop and delay of gratification task (Verhagen et al., 2015). However, Hartanto & Yang, 2013 found that DLC and SLC participants did not differ in their color-code switching task and points that although the interactional context of a bilingual is very crucial in examining bilingual task switching, the language switching history of a bilingual alone may not be an appropriate measure in determining a bilingual's interactional context. Thus, along with the interactional context, the frequency of usage of the languages, age of acquisition and proficiency become important.

Bilinguals' language-switching practices should be examined in ways that reflect the challenging quality of language control. It is very important that the current researches on bilingual language control and processing look into the effects of bilingual language experience and context. Not all bilinguals are the same and thus different bilinguals will adopt different control mechanisms depending on the context they are in.

In the current study, dense-code switching was not examined because according to the ACH, the most demanding context is the DLC and the overall aim of the study was to see if the demanding interactional context of the DLC really do modulate language control.

## **5.2. Chapter Overview**

In this chapter, the role of interactional context in bilinguals is examined. The various contexts of bilinguals are looked into in both linguistic and non-linguistic task. The chapter will report on the findings from a lexical decision task in the first experiment and reports from two non-linguistic tasks (ANT and Simon task) in the second and third experiment and a picture-audio recognition task in the fourth experiment. In particular, this chapter examines the Adaptive Control Hypothesis (Green & Abutalebi, 2013) and how the various interactional context of a bilingual leads to adaptation in language control due to the demands placed on them

## Objectives of the Chapter

This chapter will investigate the role of linguistic context on bilingual language comprehension. The linguistic context of a bilingual may involve but not limited to language use, switching practices, age of acquisition, proficiency and interactional context. The linguistic context of a bilingual also includes factors which may not necessarily be linguistics like the socio-economic background, political background etc. In this chapter, we will mainly focus on the role of interactional context in bilingual language processing. In chapter 2, section 2.4, the literature on bilingual language control is discussed and the role it plays in enhancing executive function (Bialystok et al., 2004; Costa et al., 2008). Studies have also emerged on the role of executive functions in linguistic processes and its importance in bilingual language comprehension (Novick et al., 2005; Mani & Heuttig, 2012; Nozari et al., 2016; Pickering & Gambi, 2018). While the literature seems impressive, and provides strong evidence for the interrelationship between language control and executive function, it is not clear how these evidences will play out in language communities with complex and diverse linguistic as well as socio economic and cultural background.

In this section, the linguistic situation in Nagaland in particular and northeast India and India in general is briefly highlighted. Nagaland is a state in Northeast India with 16 recognized tribes with their own distinct languages and numerous dialects making the state as one of the most diverse in terms of language and culture. Thrown into this mix of multilingual melting pot is Nagamese, a creole of Assamese, which is the lingua-franca of the state and the ever present and dominating power of English, the official language of the state. In fact, most of the people know and speak at least three languages i.e., their mother tongue, Nagamese and English. Therefore, it will be an understatement to say that language switching is practiced in this region. Similarly for other regions in Northeast India and India in general, bilingualism/multilingualism is very much a part of everyday life. Bilingualism in itself becomes complex in such communities. Therefore, it is important to examine the nuanced factors that might play a role in linguistic practices in such communities.

In this backdrop, the chapter with its base on the Adaptive Control Hypothesis (Green & Abutalebi, 2013) examines the role of interactional context in bilingual language processing. The bilingual groups under examination in this chapter are Ao-English and Nagamese-English bilinguals. For the Ao-English bilinguals, Ao is their L1 and English is identified as their L2. We examined the predictions of ACH with this group of bilinguals in a series of

linguistic and non-linguistic experiments. Whereas for the Nagamese-English bilinguals, neither of the language is their mother tongue. Also, English is the official language of the state, thus bringing the language dominance factor into play. This pair of language was chosen because we wanted to investigate the processing strategy when neither of the languages used is their L1. Also it was important to see if factors like social status (separated from the identity factor) of the language plays a role in bilingual language processing.

Four experiments in total were carried out for this chapter which comprised of two linguistic and two non-linguistic (ANT and Simon task). the research questions are listed below:

1. Does the interactional context modulate linguistic control and cognitive control?
2. What are the other factors that might modulate language control apart from interactional context?
3. Does the status of a language as L2/L3 have any role in this regard?

### **5.3. Experiment 5**

In this experiment, the effect of language context on bilingual language processing was examined. The context of bilingual experience in terms of code mixing is an important pointer for the existence of response inhibition (Adaptive Control Hypothesis, Green & Abutalebi, 2013; Hartanto & Yang, 2019). Existing literature shows that Dual language context bilinguals showed less switch cost as compared to single language context bilinguals in various tasks.

Lexical Decision Task (LDT) as discussed in chapter 3, is a linguistic task in which the participants are presented with a string of letters (stimuli) and are asked to decide if the presented string of letters is an existing word or meaningful word or not in the target language. The task is used for lexical processing and a correct 'yes' response indicates activation of the word and the response time indicates the accessibility of the word in the participant. This task is also sometimes accompanied with primes and has been used for various studies in psychology, linguistics, language disorder etc. When LDT was first introduced by Meyer and Schvaneveldt, in the 1970's, they found that participants responded faster to words that had related meanings than those that were unrelated. This showed that information related to a word can facilitate other related words. Analysis for this task is based

on response time (RT) and is aimed at understanding the organization of long-term memory and retrieval.

### 5.3.1. Participants

In this experiment, 20 bilingual participants belonging to the dual language context and 21 bilingual participants from the single language context took part in a Lexical Decision task . The participants were recruited from Nagaland and their age ranged from 21-30 years. These participants were Ao-English bilinguals with Ao as their L1 and English as L2. Besides these two languages, the participants also knew and spoke other languages like Nagamese and Hindi. Their category of language context was determined using the revised version of the Bilingual Language Interactional Context Questionnaire developed by Hartanto and Yang, 2020 (see chapter 3 and appendix C). The participants also completed a language history questionnaire adopted from LEAP-Q (Blumenfeld and Kaushanskaya, 2007, 2020) where they gave self-ratings (scale of 1-7) on their age of acquisition and proficiency, number of languages they spoke, usage of languages in various domains. Participant also completed Lextale test (Lemhofer and Broersma, 2012) to determine their L2 proficiency in which the average score for the dual context participants was 82.93% and for the single language context was 80.89%. Table 5.1 shows the self-report ratings provided by the participants on the age of acquisition and proficiency in both L1 and L2.

*Table 5.1. Self-report Rating on AoA and Proficiency*

	Dual				Single			
	Listening	Speaking	Reading	Writing	Listening	Speaking	Reading	Writing
AoA								
L1	1	2	6.1	6.25	1	1.80	5.66	5.85
L2	3.8	4	4.25	4.25	4.57	4.66	4.80	4.80
Proficiency								
L1	5.75	5.35	5	4.6	6.38	6.28	5.76	5.52
L2	5.75	5.4	5.75	5.3	6.09	5.71	6.04	5.61

### 5.3.2. Stimulus

The stimulus consisted of 40 switch trials and 120 non-switch trials. These trials consisted of both L1 (Ao) and L2 (English) words. The stimulus consisted of 40 Ao and 40 English words

and 40 Ao and 40 English non-words resulting in 160 trials. These trials were pseudo randomised so that the element of surprise and unpredictability could be maintained when the trials were presented to the participants. The stimulus used as trials in the experiment was rated on a scale of 1-10 by participants who did not take part in the main experiment. Words with an average score of 8 and above were selected for the experiment proper. Only the switch trials were considered for analysis as we were only looking for the switch effect. By looking only at the switch trials, we wanted to see if the DLC participants will be better at switching due to the demands placed on them by their interactional context.

### 5.3.3. Procedure

Participants were given verbal as well as written instructions before the experiment in both the languages. Each trial in the experiment began with a fixation (+) for 500ms after which the string of letters was presented on the screen until the participants gave a response or a maximum of 2500ms. An interval screen of 500ms was presented at the end of each trial. The participants gave their response by pressing on the assigned keys: '1' if it's an existing word or '2' if it's not an existing word. The participants were asked to respond as quickly and accurately as possible. There were 18 practise trials before the main trial. The experiment was designed on E-prime 3 (Psychology Software Tools) and presented on an HP laptop. The participants were tested individually in a quiet and distraction free room. Figure 5.1 shows a sample trial of the experiment.

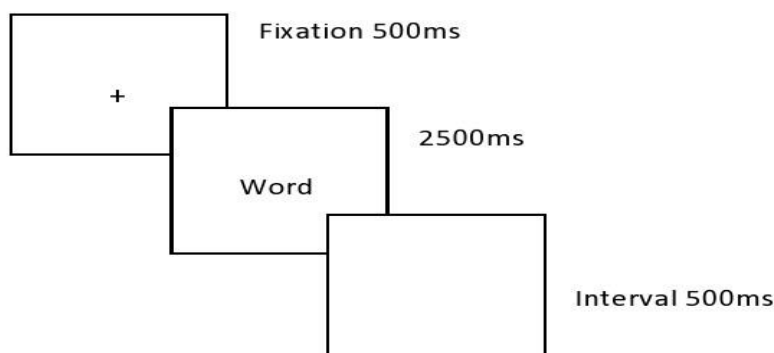


Figure 5.1. Sample of the Trials

### 5.3.4. Results

The data was trimmed by removing the outliers using the Z score normalisation. Further, errors were removed. The Dual language context data had an error of 22.50% and the single language context data had 24.52%. The DLC participants exhibited over all higher RT (M=904.08, SD=368.19) than the SLC participants (M=899.39, SD=363.49). Figure 5.2 shows the mean reaction times for the two groups of bilinguals.

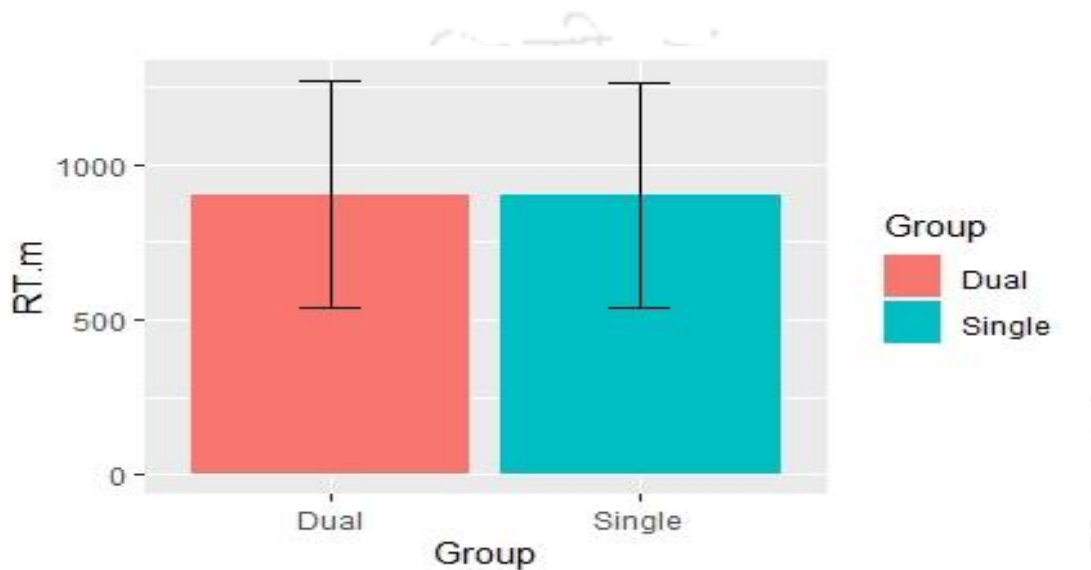


Figure 5.2. Box Plot of Mean RTs of the Two Groups

The ANOVA analysis of the two groups showed that the single language group had shorter RT by  $3.234ms$   $SE=57.189$ ,  $t=-0.057$ ,  $p=0.955$ , but it was not statistically significant as indicated by the p value. In the error analysis also no statistically significant difference was found between the DLC and SLC participants even though the SLC participants exhibited shorter RT than the DLC participants by  $232.27ms$ ,  $SE=115.14$ ,  $t=-2.017$ ,  $p=0.051$ .

### 5.3.5. Discussion

In this experiment, both the language context group performed similarly as far as the reaction time is concerned. Although the SLC group had shorter RT, it was not statistically significant. However, of particular interest is the difference between the two groups in terms of the number of errors. The SLC participants incurred a greater number of errors which could mean that the SLC participants suffered more switch cost as compared to DLC

participants. Although, their RT analysis results were similar and did not show any difference statistically, the DLC participants in lieu of their language switching context and pattern might have been able to give more accurate answers when the words presented to them was not switched. For the SLC participants, the switching of the stimulus might have had an effect since they are not used to such switching behaviour in their day-to-day life. The better performance of the DLC participants can be attributed to their interactional context and the demands placed on them because of living in a dual context environment. This is in line with the predictions of the ACH which states that the interactional demands adapt and modulates language control in bilinguals. However, the findings from this study is mixed as the DLC advantage was seen only in reduced number of errors. In fact, in this experiment we found that the SLC RT was faster than DLC which is in contradiction to other studies that found significantly faster RT in DLC participants with smaller switch cost as compared to SLC participants (Hartanto & Yang, 2016; Ng & Yang, 2021).

#### **5.4. Experiment 6**

The focus in this experiment, was to see if the language context could have an influence in a non-linguistic task, namely, Attentional Network Task. The Attentional Network Task (ANT) developed by Fan et al., 2002 is a combination of a cue reaction time task (Posner, 1980) and a flanker task (Eriksen & Eriksen, 1974). This task has been widely used to assess various issues, ranging from genetic studies of attention (Fan et al., 2003; Fossella et al., 2002), to developmental studies of attention (Rueda et al., 2004).

In the literature on interactional context, switching and inhibition task (Henrard & van Daele, 2017; Ooi et al., 2018; Yang et al., 2016) have been used to examine the role of interactional context in bilinguals. Since the DLC advantage was not found in experiment 5 which was a language switching task, the logical option was to see if the DLC advantage could be found in some already established measures. Only one variable was changed or modified, that is the experimental paradigm and kept all the rest like the participants the same as experiment 1.

##### **5.4.1. Participants**

The participants were the same as in experiment 5.

### 5.4.2. Stimulus

In this task, participants are asked to indicate whether a central arrow (>) points to the right or left. This arrow is presented along with flanker arrows pointing to the same (congruent trials >>>>>) or different direction (incongruent trials <<<<<) than the target arrow. Responses tend to be slower for incongruent than for congruent trials, revealing the time needed to resolve the conflict between the target stimulus and the to-be-ignored flanker information. This conflict effect has been used to explore the functioning of the executive control network. The functioning of the alerting network is studied by presenting a cue before the target stimulus: responses are faster when the target is preceded by an alerting cue than when it is not. Alongside, the task also factors in the function of orienting; the orienting network is explored by presenting a cue that signals the position in the screen where the target stimulus will appear (Spatial cue, above or below). Responses are faster when the cue signals the position of the target than when it does not give information about the target's spatial location.

Together, the cue detection ability and inhibition of irrelevant cues (in non-congruent trials) marks the performance of the participants.

It was expected that the participants in dual language context (DLC) will be better at ignoring the interference produced by incongruent trials than the participants in single language context (SLC). Switching between different types will be less costly for DLC than SLC and participants in DLC will be faster in both congruent and incongruent trials.

For this experiment, series of arrows were used as stimulus. There were three conditions, Congruent, in which the central arrow was pointing in the same direction as the flanker arrows, incongruent condition, in which the central arrow was pointing in the opposite direction of the flanker arrows and neutral conditions, in which all the arrows were pointing in the same direction. There were 40 trials in each condition, leading to 120 trials in total. Before the presentation of the stimulus, cues were presented on the screen. The cues were divided into three types, namely: central cue, in which the cue was presented at the centre of the screen, spatial cue, in which the cue was presented on the top or bottom of the screen and no cue, in which there was no cue presented. Thus, there were three types of conditions and three cue type. The trials were again equally distributed between the three cue types. Figure 5.3 shows the types of condition and cues.

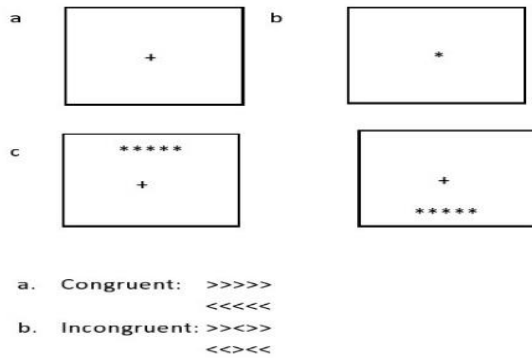


Figure 5.3. Types of Cues

### 5.4.3. Procedure

Each trial began with a fixation (+) for 500ms, after which the cue was presented for 1000ms. Then a fixation appeared on the screen for 500ms after which the stimulus was presented until a response was given or a maximum of 2000ms. The participants had to respond by pressing the assigned keys on the keyboard. The participants were given verbal as well as written instructions before the start of the experiment. The participants were also given 18 practise trials before the main trial. The experiment was designed on Eprime-3 (PST) and presented on a HP laptop. The participants were tested individually and in a quiet room. Informed consent was given by the participants for their participation. The instructions for the test were presented on the screen as well as verbal instructions were given. Figure 5.4 shows a sample of the trial in the experiment.

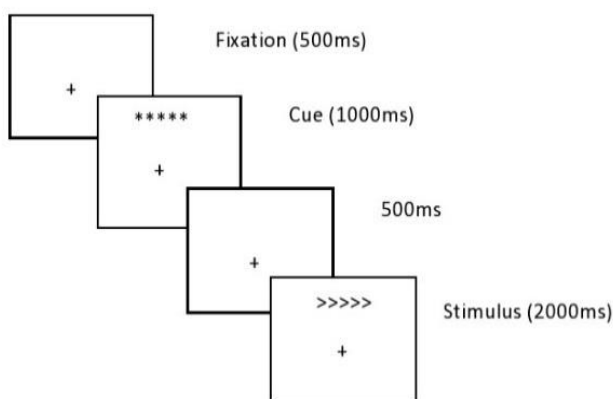


Figure 5.4. Schematic Representation of the Trials

#### 5.4.4. Results

Outliers were removed using Z score normalization and the errors were also removed. For the correct response RT analysis, the data was first analysed according to the cue type and then the condition type. First group wise analysis was done and then combined analysis of the two groups to see if there was any statistically significant difference between the two groups. Table 5.2 depicts the error rates incurred by each group. The participants in the dual context had more errors as compared to single category group but their RT was lesser as compared to the single language group. The data analysis was done on R studio.

Table 5.2. Error Rate

	Dual	Single
Condition Type		
Congruent	1.75%	2.26%
Incongruent	12.25%	7.14%
Neutral	2.50%	1.66%
Cue Type		
Centre Cue	5.87%	3.80%
No Cue	5.62%	3.57%
Spatial Cue	5%	3.69%

##### 5.4.4.1. Dual Group Analysis

###### Cue Type

In the cue type response analysis, center cue had the highest RT ( $M=621.55$ ,  $SD=181.24$ ) followed by no cue ( $M=621.40$ ,  $SD=175.71$ ) and with the lowest RT in the spatial cue ( $M=608.59$ ,  $SD=177.46$ ). Figure 5.5 shows the mean reaction time across cue type.

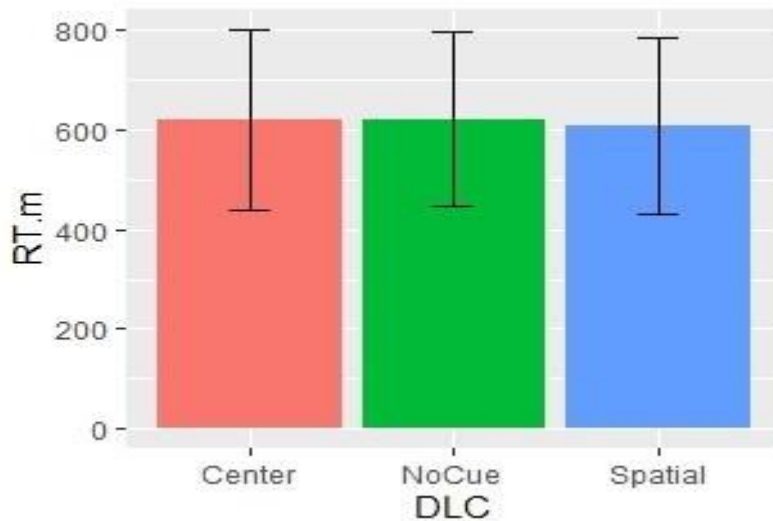


Figure 5.5. Mean RTs of the Three Cue Types

Table 5.3 shows the results from Bonferroni post hoc analysis which reveals that there was no statistically significant difference between the center and no cue with higher RT for center cue by  $1.24ms$ ,  $SE=8.13$ ,  $t=0.152$ ,  $p=1.00$ , center and spatial cue with higher RT in the center cue by  $15.27ms$ ,  $SE=8.12$ ,  $t=1.881$ ,  $p=0.1804$  and no cue and spatial cue with higher RT in the no cue type by  $14.03ms$ ,  $SE=8.11$ ,  $t=1.730$ ,  $p=0.2515$ .

Table 5.3: Post hoc analysis for RT

contrast	estimate	SE	Df	t.ratio	p.value
Center-NoCue	1.24	8.13	2246	0.152	1.0000
Center-Spatial	15.27	8.12	2246	1.881	0.1804
NoCue-Spatial	14.03	8.11	2246	1.730	0.2515

The error analysis also revealed no statistically significant difference between the center cue and no cue with higher RT in center cue by  $66.6ms$ ,  $SE=77.8$ ,  $t=0.856$ ,  $p=1.00$ , center cue and spatial cue with higher RT in the center cue by  $53.3ms$ ,  $SE=81.4$ ,  $t=0.654$ ,  $p=1.00$  and no cue and spatial cue with shorter RT in no cue by  $13.3ms$ ,  $SE=82.9$ ,  $t=-0.161$ ,  $p=1.00$ .

## Condition Type

In the condition type analysis, incongruent condition had the highest RT (M=706.46, SD=188.10) followed by neutral condition (M=584.47, SD=157.30) and with the lowest RT in the congruent condition (M=569.83, SD=157.30). Figure 5.6 shows the mean reaction times of the conditions in DLC participants.

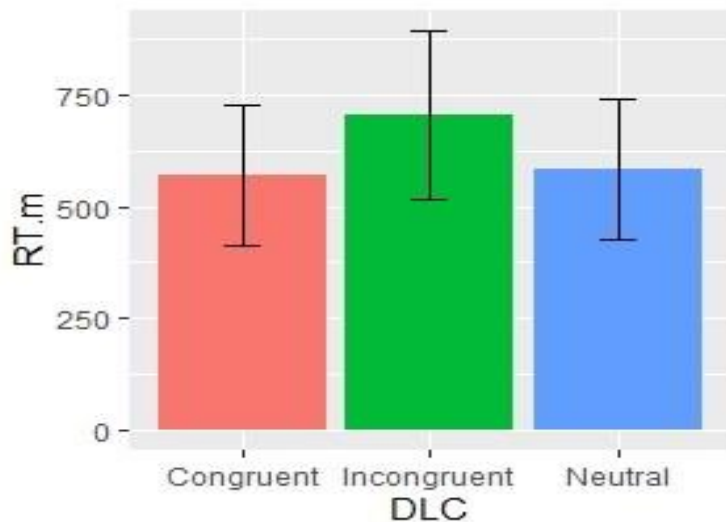


Figure 5.6. Mean RTs of the Three Conditions

Table 5.4 provides the results of the Bonferroni post hoc analysis, which showed statistically significant difference between congruent and incongruent condition with the congruent condition incurring shorter RT by 149.8ms,  $SE=7.50$ ,  $t=-19.973$ ,  $p<0.0001$  and between incongruent and neutral condition with higher RT in the incongruent condition by 134.4ms,  $SE=7.51$ ,  $t=17.89$ ,  $p<0.0001$ . No statistically significant difference was found between congruent and neutral condition even though congruent condition had shorter RT by 15.4ms,  $SE=7.26$ ,  $t=-2.122$ ,  $p=0.1020$ .

Table 5.4. Post hoc analysis of RT of Condition Type for DLC

contrast	estimate	SE	Df	t.ratio	p.value
Congruent-Incongruent	-149.8	7.50	2247	-19.973	<.0001
Congruent-Neutral	-15.4	7.26	2246	-2.122	0.1020
Incongruent-Neutral	134.4	7.51	2247	17.893	<.0001

In the error analysis, there was no statistical significant difference between congruent and incongruent condition with higher RT in the congruent condition by  $8.51ms$ ,  $SE=103$ ,  $t=0.083$ ,  $p=1.00$ , congruent and neutral condition with higher RT in the congruent condition by  $195.11ms$ ,  $SE=117.6$ ,  $t=1.659$ ,  $p=0.2982$  and incongruent and neutral condition with higher RT in the incongruent condition by  $186.60ms$ ,  $SE=92.4$ ,  $t=2.019$ ,  $p=0.1360$ .

#### 5.4.4.2. Single Language Group Analysis

##### Cue Type

In the cue type analysis of the SLC participants, center cue had the highest RT ( $M=681.44$ ,  $SD=222.38$ ) followed by no cue ( $M=681.04$ ,  $SD=192.17$ ) with the lowest RT in the spatial cue ( $M=670.08$ ,  $SD=192.17$ ). Figure 5.7 shows the mean reaction time of the cue types.

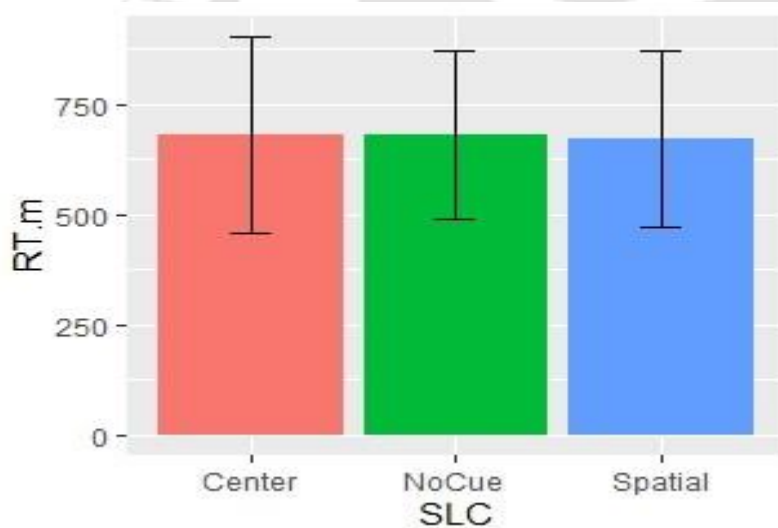


Figure 5.7. Mean RTs of the Three Cue Types

Table 5.5 shows the results post hoc analysis which revealed that there was no statistically significant difference between center and no cue with higher RT in the center cue by  $0.365ms$ ,  $SE=8.7$ ,  $t=0.042$ ,  $p=1.00$ , center and spatial cue with higher RT in center cue by  $11.17ms$ ,  $SE=8.7$ ,  $t=1.285$ ,  $p=0.59$  and no cue and spatial cue type by  $10.814ms$ ,  $SE=8.7$ ,  $t=1.244$ ,  $p=0.64$ .

Table 5.5. Post hoc analysis of RT

contrast	estimate	SE	Df	t.ratio	p.value
Center-NoCue	0.365	8.7	2404	0.042	1.00
Center-Spatial	11.179	8.7	2404	1.285	0.59
NoCue-Spatial	10.814	8.7	2404	1.244	0.64

In the error analysis also, there was no evidence of statistically significant difference from the post hoc analysis. The results revealed that there was no significant difference between center cue and no cue despite center cue with shorter RT of  $242.1ms$ ,  $SE=115$ ,  $t=-2.009$ ,  $p=0.11$ , center cue and spatial cue with shorter RT in the center cue by  $61.8ms$ ,  $SE=114$ ,  $t=0.540$ ,  $p=1.00$  and no cue and spatial cue with higher RT in the no cue type by  $180.3ms$ ,  $SE=115$ ,  $t=1.561$ ,  $p=0.36$ .

### Condition Type

In the condition type analysis of the SLC date, the participants exhibited higher RT in the incongruent condition ( $M=792.49$ ,  $SD=236.170$ ) followed by neutral condition ( $M=626.91$ ,  $SD=162.16$ ) with the lowest RT in the congruent condition ( $M=619.20$ ,  $SD=163.11$ ). Figure 5.8 shows the mean reaction times of all the three conditions.

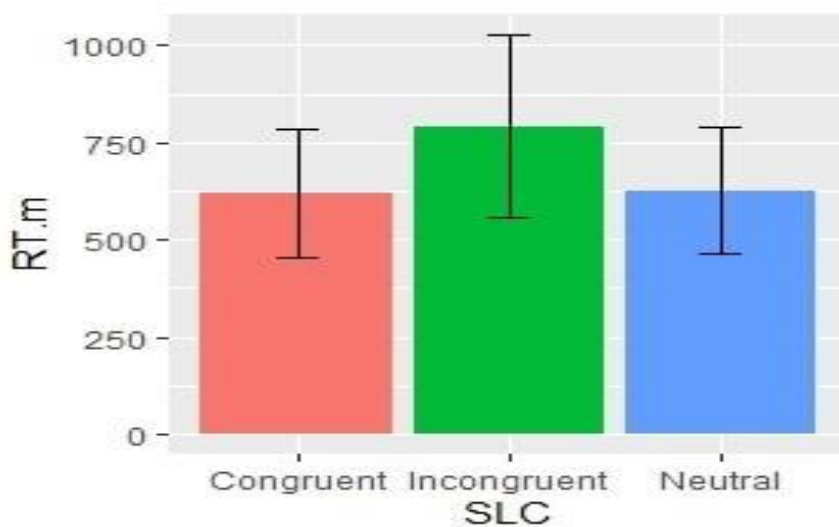


Figure 5.8. Mean RTs of the Three Conditions

Table 5.6 shows the results of the post hoc analysis of the condition type revealed that there was statistically significant difference between congruent and incongruent condition with shorter RT in the congruent condition by  $173.6ms$ ,  $SE=7.83$ ,  $t=-22.178$ ,  $p<0.0001$  and incongruent and neutral condition with higher RT in the incongruent condition by  $165.7ms$ ,  $SE=7.82$ ,  $t=21.183$ ,  $p<0.0001$ . However, there was no statistically significant difference between congruent and neutral condition with shorter RT in the congruent condition by  $7.8ms$ ,  $SE=7.69$ ,  $t=-1.014$ ,  $p=0.9315$ .

Table 5.6. Post hoc analysis of RT

contrast	estimate	SE	Df	t.ratio	p.value
Congruent- Incongruent	-173.6	7.83	2405	-22.178	<.0001
Congruent-Neutral	-7.8	7.69	2404	-1.014	0.9315
Incongruent-Neutral	165.7	7.82	2405	21.183	<.0001

In the error analysis also, statistically significant difference was found between the congruent and incongruent condition with shorter RT in the congruent condition by  $688.5ms$ ,  $SE=116$ ,  $t=-5.927$ ,  $p<0.001$  and incongruent and neutral condition with higher RT in the incongruent condition by  $621.8ms$ ,  $SE=126$ ,  $t=4.916$ ,  $p<0.0001$ . In the error analysis also, there was no statistically significant difference between the congruent and neutral condition with shorter RT in the congruent condition by  $66.7ms$ ,  $SE=147$ ,  $t=-0.453$ ,  $p=1.00$ .

### Combined Analysis

The combined analysis of the two groups was first done according to the cue type and then the condition type.

### Cue Wise Analysis

The effect of the group was not seen even though DLC had overall shorter RT by  $55.7ms$ ,  $SE=31.5$ ,  $t=-1.768$ ,  $p=0.0842$ . ANOVA results revealed that there was statistically significant difference between the cue types,  $F(2, 4654)=3.0683$ ,  $p=0.046$ . In the post hoc analysis of the cues, spatial cue had the overall shorter RT than center cue and no cue by  $0.78ms$ , which was statistically insignificant,  $p=0.89$ . Overall SLC group had higher RT than

DLC group by  $55.68ms$ ,  $SE=31.50$ ,  $t=1.768$ ,  $p=0.084$ , but it was not statistically significant as indicated by the  $p$  value. Figure 5.9 shows the mean reaction times of cue types in both groups.

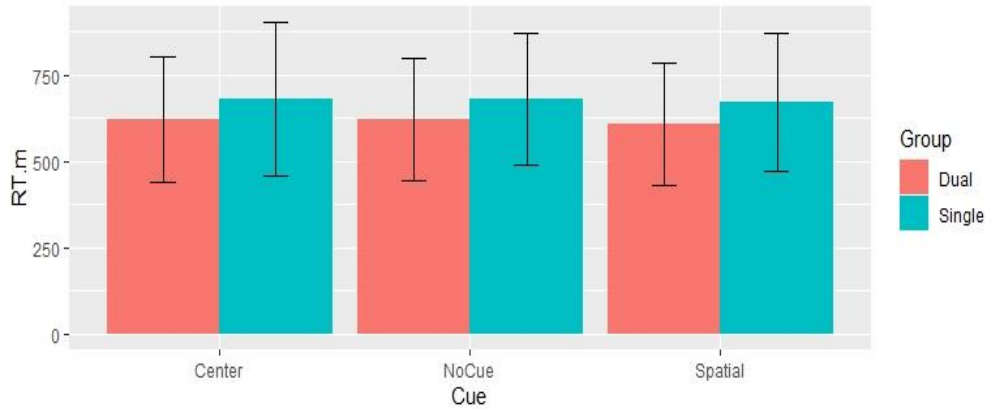


Figure 5.9. Mean RTs According to Cue Type

In the error analysis, SLC group had overall shorter RTs than DLC group which was statistically significant by  $392.26ms$ ,  $SE=130.97$ ,  $p=0.00464$ . No cue and center cue had shorter RTs by  $85.36ms$ ,  $SE=85.05$ ,  $P=0.31$  and  $64.56ms$ ,  $SE=88.72$ ,  $p=0.46$ , but both were not significant as indicated by the  $p$  value. Within the SLC group, no cue and spatial cue had higher RT, no cue by  $328.56ms$ ,  $SE=134.15$ ,  $p=0.01$  and spatial cue by  $126.63ms$ ,  $SE=135.93$ ,  $p=0.015$ . Thus, spatial cue was statistically significant from center cue and no cue.

### Condition Wise Analysis

In the combined analysis of the condition type data, ANOVA revealed that there was statistical significant difference between the condition,  $F(2, 4655)=4.4692$ ,  $p=0.011$ . Overall, the post hoc analysis indicated higher RT for SLC group, but it was not significant,  $49.421ms$ ,  $SE=32.10$ ,  $p=0.1309$ . Among the conditions, incongruent condition had overall higher RT by  $49.421ms$ ,  $SE=7.840$ ,  $p<0.05$ . Within the incongruent condition, SLC participants incurred higher RT by  $23.76ms$ ,  $SE=10.86$ ,  $p=0.028$ . Table 5.7 shows the post hoc analysis results.

Table 5.7. Mixed Effects for RT

	estimate	SE	P
(Intercept)	570.705	22.977	<2e-16
GroupSingle	49.421	32.108	0.1309
ConditionIncongruent	149.781	7.840	<2e-16
ConditionNeutral	15.392	7.585	0.0425
GroupSingle:ConditionIncongruent	23.766	10.867	0.0288
GroupSingle:ConditionNeutral	-7.590	10.595	0.4738

Figure 5.10 provides the two language context participants across conditions.

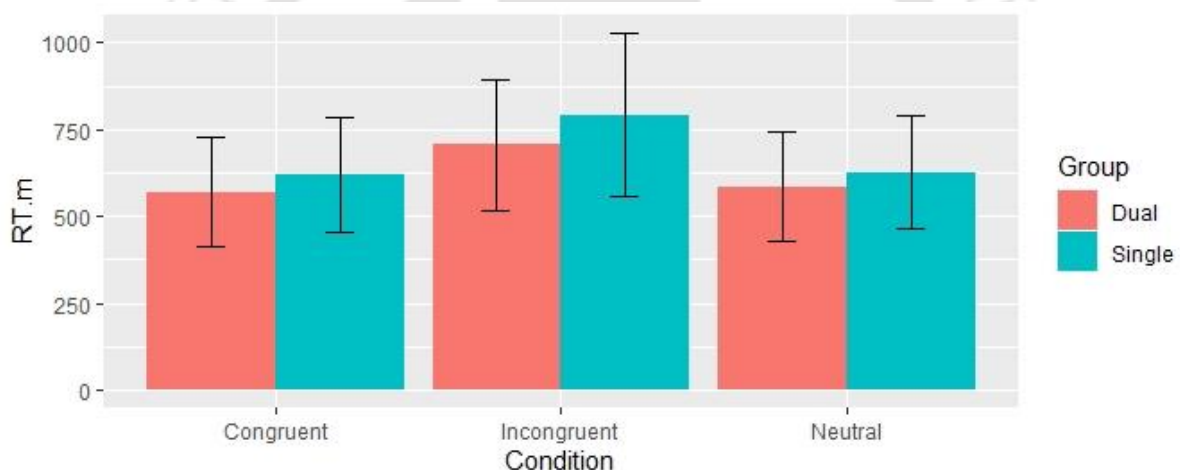


Figure 5.10. Mean RTs of Condition Type in Both the Groups

In the error analysis, the SLC group had overall shorter RT by 622.39ms,  $SE=179.97$ ,  $p=0.0008$ , which is statistically significant. Incongruent condition had overall higher RT by 61.41ms,  $SE=115.73$ ,  $p=0.59$ , which is not significant. Within the incongruent condition, there was statistically significant difference between SLC and DLC participants with higher RT in the SLC group by 475.86ms,  $SE=153.91$ ,  $p=0.0022$ . Neutral condition had overall shorter RT than congruent and incongruent condition by 175.53ms but it was not statistically significant,  $p=0.17$ . Within the neutral condition, there was no significant difference between the DLC and SLC, even though higher RT was incurred by the single language context participants by 214ms,  $SE=186.38$ ,  $p=0.25$ . Table 5.8 provides the results of the post hoc analysis.

Table 5.8. Mixed Effects of Error RT of Combined Condition Type

Fixed effects	estimate	SE	P
(Intercept)	575.78	131.18	3.2e-05
GroupSingle	-622.39	179.97	0.000869
ConditionIncongruent	61.41	115.73	0.596209
ConditionNeutral	-175.53	129.75	0.177565
GroupSingle:ConditionIncongruent	475.86	153.91	0.002246
GroupSingle:ConditionNeutral	214.10	186.38	0.251946

## Discussion

The aim of this experiment was to see if the bilingual context has an effect on the Attention Network Task. Although there was no statistically significant difference, both DLC and SLC participants had shorter RT in the spatial cue type which shows the orienting effect of the spatial cue in both the groups of participants. This means that the participants were able to take advantage of the orienting cues and thus were able to respond faster. The effect of the incongruent condition was seen in both the groups which was statistically significant. It shows that the participants took longer time to respond to the incongruent cues as compared to the congruent and neutrals cues. However, in the combined analysis, SLC participants overall incurred higher RT as compared to the DLC participants. The DLC participants suffered less interference from the incongruent trials and were overall faster in response time. These results indicate that the language context exerts an effect on the executive control and the alerting and orienting networks. Overall, participants were faster when a cue was presented, when the cue indicated the location of the target stimulus and the flankers around the target stimulus was presented in the same direction. Exp 6 is in line with Exp 5 in that the DLC participants benefitted from the demands of its linguistic context as the DLC participants performed better than SLC in both linguistic and non-linguistic task.

### 5.5. Experiment 7: Simon Task

Simon task (Simon, 1963) is a task in which participants have to respond according to a dimension of the target stimulus (e.g., colour) while ignoring an irrelevant one (e.g., position on the screen). The combination of the two dimensions leads to congruent and incongruent

trials. For example, participants may be told to press the right response key if a blue square appears and the left response key if a green square appears. These stimuli are presented on the left or right sides of the screen so that position information becomes part of the stimulus display although it is not relevant to response selection. In congruent items, the irrelevant spatial position supports the rule-directed correct response (e.g., blue square on right side); in incongruent items, the irrelevant spatial position conflicts with the correct response (e.g., blue square on left side). The task, therefore, requires inhibitory control to ignore the irrelevant position information in the incongruent trials. Responses tend to be slower for incongruent than for congruent trials (the Simon effect), an effect that reveals the cost associated with resolving the incompatible information given by the two dimensions. Bialystok (2004, 2005, 2006) has consistently found that bilingual participants tend to be overall faster than monolinguals in tasks that involve inhibitory control such as the Simon task. It was also found that reaction times were faster in the congruent condition compared to incongruent condition. Simon congruency effect is seen in older bilinguals than age matched monolinguals (Bialystok et al., 2005, 2007, 2008). While others report no significant difference in RTs and accuracy (Guido-Mendes, 2015) and no interaction between group and congruency conditions, even when controlling the bilingual group for native speakers, second language (L2) spoken, and immigration status (Paap & Greenberg, 2013).

### **5.5.1. Participants**

The same Ao-English bilinguals from experiment 5 and 6 participated in this experiment.

### **5.5.2. Stimulus**

Two square boxes were used as stimulus in this experiment. The boxes were colour coded: green was left and red was right. The position in which the boxes appeared did not matter, but the colour of the box determined the response to be given. This conflicting information between the colour and the position of the screen would result in interference and thus conflict resolution. There were three conditions: congruent (when the colour of the box and the spatial position matched), incongruent (when there was a mismatch) and neutral (where the box appeared in the centre of the screen). There were 30 trials in total, 10 trials for each condition.

### 5.5.3. Procedure

The trials began with a fixation (+) for 500ms after which the stimulus was presented on the screen till a response was given by the participants or a maximum of 2000ms. An interval screen of 500ms was presented at the end of each trial. The participants had to respond by pressing the 'left' and 'right' key on the keyboard. The participants were tested individually and they were given verbal as well as written instructions before the start of the experiment. The participants were also given some practice trials before the main trial. The experiment was designed on Eprime-3 (PST) and presented on an HP laptop. The participants were tested individually and in a quiet room. Figure 5.11 shows a sample trial of the experiment,

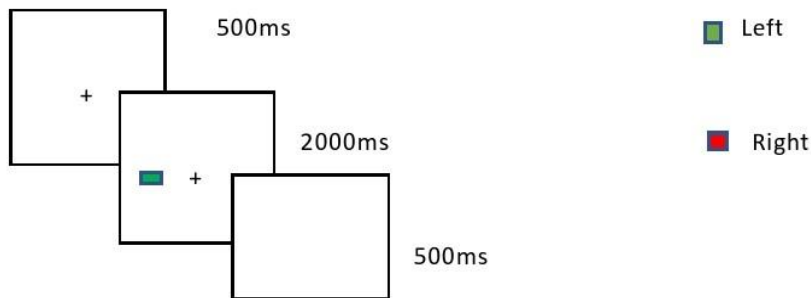


Figure 5.11. Schematic Representation of the Trials

### 5.5.4. Results

Errors as well as outliers were removed before the analysis. For the removal of outliers, zscore normalization was used. Only the correct responses were analysed using the repeated measures ANOVA.

Table 5.9. Error Rates

	<b>Congruent</b>	<b>Incongruent</b>	<b>Neutral</b>
Dual	3.50%	8%	3.50%
Single	3.33%	14.28%	3.33%

## Dual Language Context Group

In the DLC group, congruent condition had the highest RT ( $M=578.62$ ,  $SD=225.47$ ) followed incongruent condition ( $M=560.94$ ,  $SD=238.90$ ) and neutral condition with the shortest RT ( $M=533.10$ ,  $SD=170.55$ ). Figure 5.12 shows the mean reaction times of the conditions in DLC.

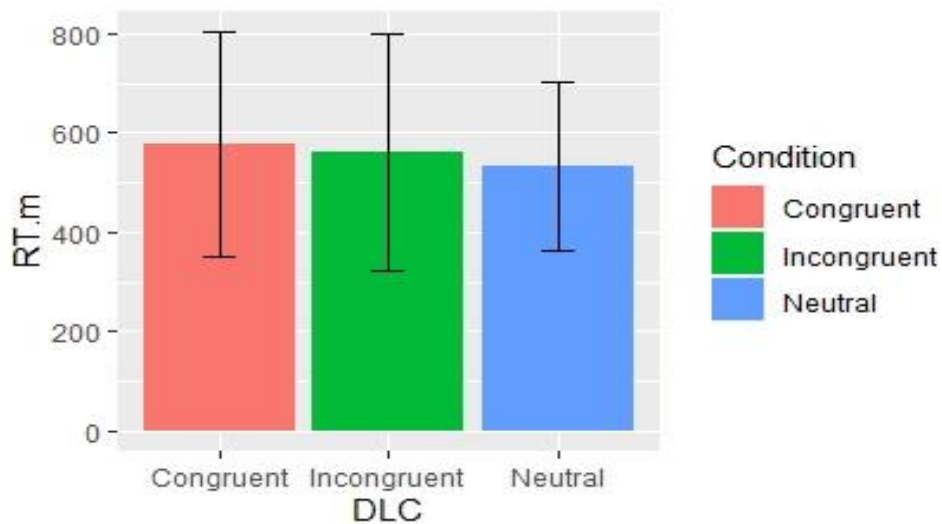


Figure 5.12. Mean Reaction Times of the Conditions

In the ANOVA analysis, statistically significant difference was found between the conditions,  $F(2, 548)=8.268$ ,  $p=0.009$ . Bonferroni post hoc analysis on the conditions revealed that there was statistically significant difference only between congruent and neutral condition with higher RT in the congruent condition by  $55.3ms$ ,  $SE=18.1$ ,  $t=3.049$ ,  $p=0.0072$ . No significant difference was found between congruent and incongruent condition with higher RT in the congruent condition by  $25.4ms$ ,  $SE=18.4$ ,  $t=1.381$ ,  $p=0.5032$  and between incongruent and neutral condition with higher RT in the incongruent condition by  $29.9ms$ ,  $SE=18.3$ ,  $t=1.631$ ,  $p=0.3102$ . Table 5.10 provides the results of the post hoc analysis.

Table 5.10. Post hoc analysis of RT

contrast	estimate	SE	Df	t ratio	p value
Congruent - Incongruent	25.4	18.4	548	1.381	0.5032
Congruent - Neutral	55.3	18.1	548	3.049	0.0072
Incongruent - Neutral	29.9	18.3	548	1.631	0.3102

### Single Language Context Group

In the response time analysis of the SLC data, the incongruent condition had the highest RT ( $M=600.88$ ,  $SD=195.40$ ) followed by congruent condition with the lowest RT ( $M=594.50$ ,  $SD=169.81$ ) and neutral condition ( $M=599.31$ ,  $SD=261.22$ ). Figure 5.13 shows the mean reaction times of the conditions.

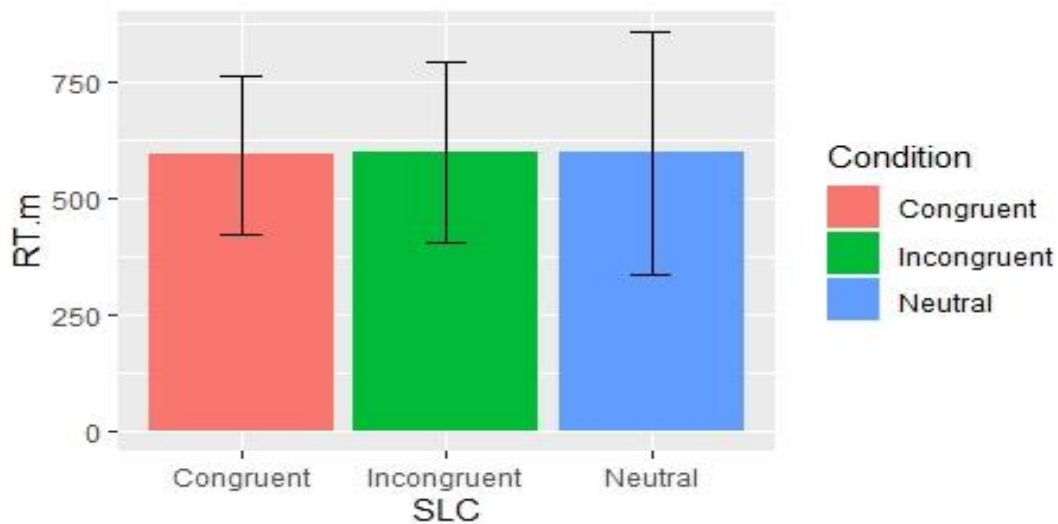


Figure 5.13. Mean Reaction Times Across Conditions

The ANOVA analysis showed that there was no statistically significant difference between the conditions,  $F(2, 563)=0.048$ ,  $p=0.954$ . There was very little difference between the reaction times for all the three condition and Bonferroni post hoc analysis showed that there was statistically no significant difference between congruent and incongruent condition with shorter RT in congruent condition by  $2.15ms$ ,  $SE=18.3$ ,  $t=-0.117$ ,  $p=1.00$ , congruent and neutral condition with shorter RT in the congruent condition by  $4.25ms$ ,  $SE=17.8$ ,  $t=-0.239$ ,  $p=1.00$  and incongruent and neutral condition with shorter RT in the incongruent condition by  $2.10ms$ ,  $SE=18.3$ ,  $t=-0.115$ ,  $p=1.000$ . Table 5.11 provides the results of the post hoc analysis.

Table 5.11. Post hoc analysis of RT

contrast	estimate	SE	Df	t ratio	p value
Congruent - Incongruent	-2.15	18.3	563	-0.117	1.0000
Congruent - Neutral	-4.25	17.8	563	-0.239	1.0000
Incongruent - Neutral	-2.10	18.3	563	-0.115	1.0000

## Combined Analysis of the Two Groups

Figure 5.14 shows the mean reaction times across conditions for both groups

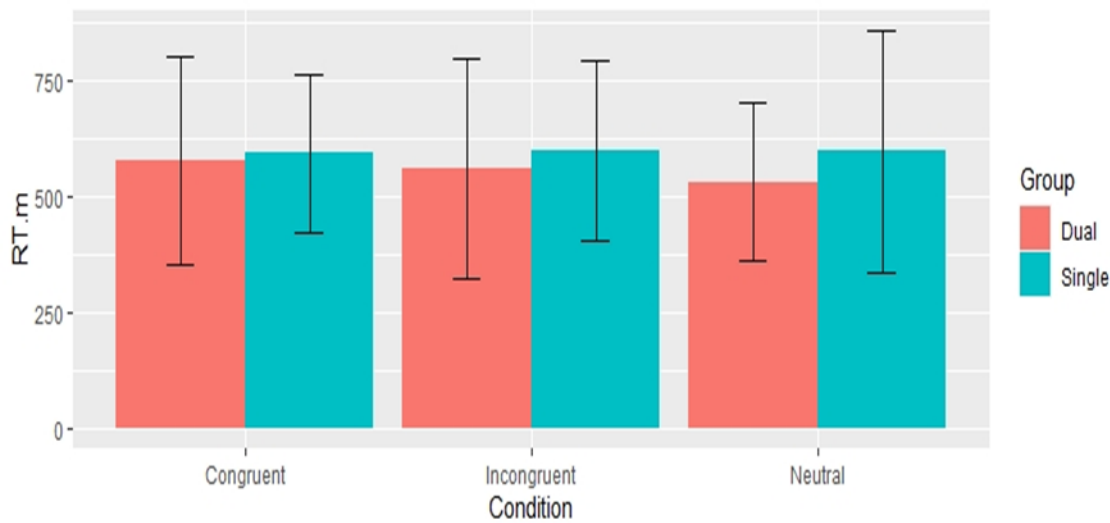


Figure 5.14. Mean reaction times across condition for both groups

The RT analysis revealed that there was significant difference between the SLC group and DLC group,  $F(2, 1113)=1.8967, p=0.1506$ . In the combined analysis, linear mixed model analysis with RT as the dependent variable and group (DLC and SLC), condition (congruent, incongruent and neutral) and their interactions as fixed effects revealed that there was no statistically significant difference between the groups with higher RT in the SLC group as compared to DLC group by  $36.18ms, SE=38.81, t=0.925, p=0.361$ . Both the groups responded faster to the incongruent condition but was not statistically significant with a difference of  $11.20ms, SE=12.99, t=-0.862, p=0.389$ . Hence, the effect of the incongruent condition was not found. Overall, neutral condition had the shortest RT but it was also not statistically significant with a difference of  $11.20ms, SE=12.99, t=-1.945, p=0.389$ .

Table 5.12. Mixed Effects Model of RT

Fixed effects	estimate	SE	t.value	p.value
(Intercept)	571.86	28.94	19.762	<2e-16 ***
GroupSingle	36.18	38.81	0.925	0.361
ConditionIncongruent	-11.20	12.99	-0.862	0.389
ConditionNeutral	-24.73	12.71	-1.945	0.052

In the error analysis, ANOVA results indicated significant difference between the groups,  $F(1, 32)=5.7743$ ,  $p=0.022$ , but no such difference was found for conditions,  $F(2, 32)=0.0178$ ,  $p=0.98$ . Overall RT was higher in the SLC group as compared to the DLC group by  $256.87ms$ ,  $SE=106.90$ ,  $t=2.403$ ,  $p=0.02241$  which is statistically significant. The effect of the incongruent condition was not found. Table 5-12 shows the results of the post hoc analysis.

Table 5.13. Mixed Effects Model of Error RT

Fixed effects	estimate	SE	t.value	p.value
(Intercept)	337.54	81.47	4.143	0.00023
GroupSingle	256.87	106.90	2.403	0.02241

## Discussion

Overall, the DLC participants had faster RT as compared to the SLC participants. There was also significant difference between the three conditions in the SLC group which shows that the DLC participants were more efficient in conflict monitoring. However, the SLC participants were not as efficient and therefore incurred more RT as well as significant difference between the conditions. This shows that because of DLC participants constant switching of languages modulated their performance in the Simon task and they were better than the SLC participants.

## 5.5. Experiment 8

### Introduction

In this experiment, we tried to look at the linguistic context of bilinguals taking two languages neither of which is the first language. Our participants were from Nagaland. The state presents a very unique social and linguistic situation. Because the state has many tribes with their own languages which are mutually unintelligible, interaction between the tribes becomes complex. In addition to that, there is Nagamese, which is a creole used by the people for inter-tribe communication. The state government recognises English as the official language of the state and is used for all formal communication. Between Nagamese and

English, the latter has the higher status because of its recognition by the state government. English is also used as a medium of instruction in school education, thus it has the written form as well. However, Nagamese is still used only as a spoken language and is used mostly for communication amongst the people and in the media (TV, social media etc) in the recent years. Like in most parts of India, English is also regarded as the language a person must know to advance in life. Knowing English means better social and economic status. Thus, English as a language is given more priority in the state as well.

In this experiment, the two languages used i.e., Nagamese and English are both non-L1 languages of the participants. However, they differ linguistically and socially. English is used in a formal setting and has a written form while the other language, Nagamese is used in informal setting and it does not have a written form. The aim of the experiment was to see if these two non-L1 languages are processed differently by the bilingual speakers owing to their differences as mentioned above.

This task was an audio-picture matching task. In this task, the participants had to identify if there is a match between a picture and a corresponding audio clip played through a headphone.

### **Participants**

The participants in this experiment were university students from Nagaland belonging to different tribes and from different universities across India. The participants were all multilinguals and spoke Nagamese and English apart from their first languages. There were 30 participants in total. The participants ranged in age from 20-40 years ( $M=27.63$ ,  $SD=4.33$ ). The participants completed a language history questionnaire adapted from LEAP-Q (Hartanto & Yang, 2016, 2020) where they gave self-report ratings on the AoA of the languages they knew and also the proficiency. The participants also completed the Lextale test for English proficiency and the average score was 84.90%. The same test was adapted for the Nagamese proficiency and the participants completed the same with an average score of 84.52%. Before the experiment, the participants gave informed consent for their participation in the experiment. Table 5.14 gives the data on self-report ratings of the participants.

Table 5.14. Self-report Rating on AoA and Proficiency

	<b>English</b>	<b>Nagamese</b>
	<b>M(SD)</b>	<b>M(SD)</b>
AoA	3.66(1.32)	6.16(4.04)
Proficiency		
Listening	6.13(0.80)	6.06(0.85)
Speaking	5.6(0.75)	5.76(1.02)
Reading	7.03(0.83)	4.6(1.68)
Writing	5.7(0.78)	4.03(1.87)

### Stimulus

In this experiment audio clips and pictures were used. The audio outputs were recorded by a female speaker of Nagamese and English and this speaker did not take part in the main experiment. The experiment consisted of three blocks, English block, Nagamese Block and Mixed block, which was a mix of both the languages. The experiment was a picture-audio recognition task. The stimulus consisted of 40 pictures and 80 English audio clips for the English block and 40 pictures and 80 Nagamese audio clips for the Nagamese block. Out of the 80 audio clips, 40 matched with the pictures and 40 did not match. These resulted in 40 match trials and 40 mismatch trials in each block, resulting in 80 trials in total for each of the single language blocks. In the mixed block, the stimuli from the single language blocks were used consisting of 40 match trials each for English and Nagamese and 80 mismatch trials each for both Nagamese and English resulting in 160 trials in total.

### Procedure

Each trial in all the blocks started with a fixation '+' for 500ms which was followed by the picture presented on the screen for 1000ms after which the audio was played. The participants had 3000ms to respond. The participants gave their response by pressing the assigned keys on the keyboard, '1' if the picture and the audio matched and '2' if the picture and the audio did not match. An interval of 250ms was presented after each trial. Practice

trials were given before each block. Figure 5.15 depicts a trial procedure. The experiment was designed on Eprime 3 (PST).

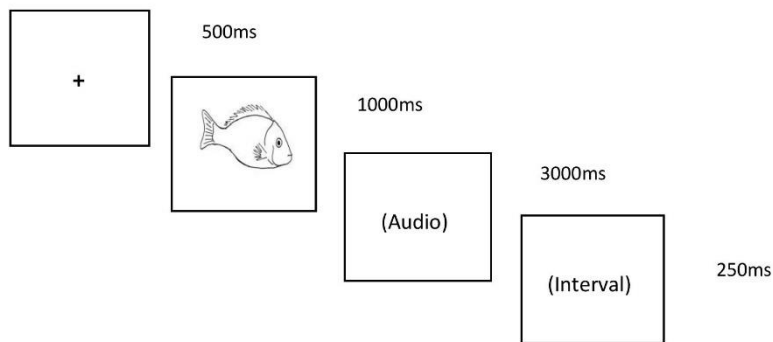


Figure 5.15. Sample Trial

## Results

### English Block

In the English block, mismatch trials had higher RT ( $M=1233.166$ ,  $SD=273.78$ ) than match trials ( $M=1084.99$ ,  $SD=251.18$ ). Figure 5.16 shows the mean reaction times of match and mismatch trials.

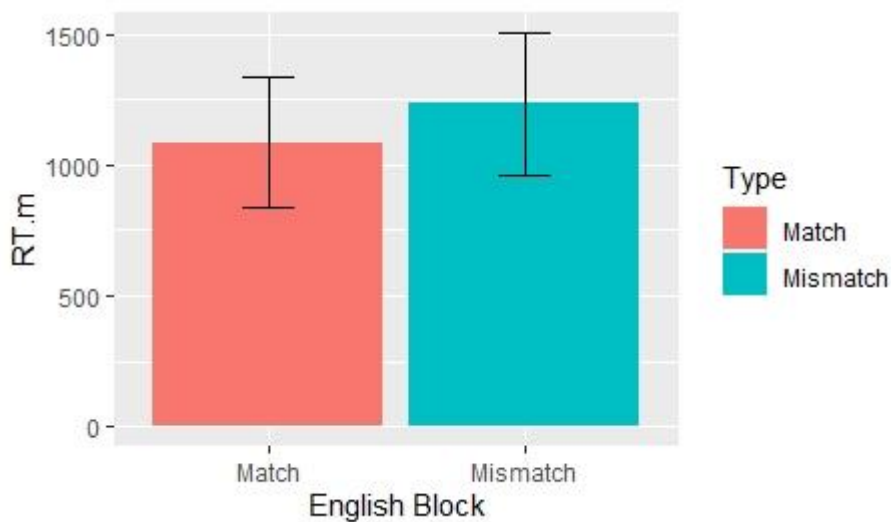


Figure 5.16. Mean RTs of the Two Types of Trials

The ANOVA results showed that there was statistically significant difference between match and mismatch trials,  $F(1,2274)=180.9$ ,  $p>0.05$ .

In the error analysis, there was no statistically significant difference between the two trial types,  $F(1, 53)=0.105$ ,  $p=0.747$ .

### Nagamese Block

In the Nagamese block analysis, higher RT was observed in the match trial ( $M=1359$ ,  $SD=304.65$ ) than in mismatch trials ( $M=1243.77$ ,  $SD=291.78$ ). Figure 5.17 shows the mean reaction time of the trials.

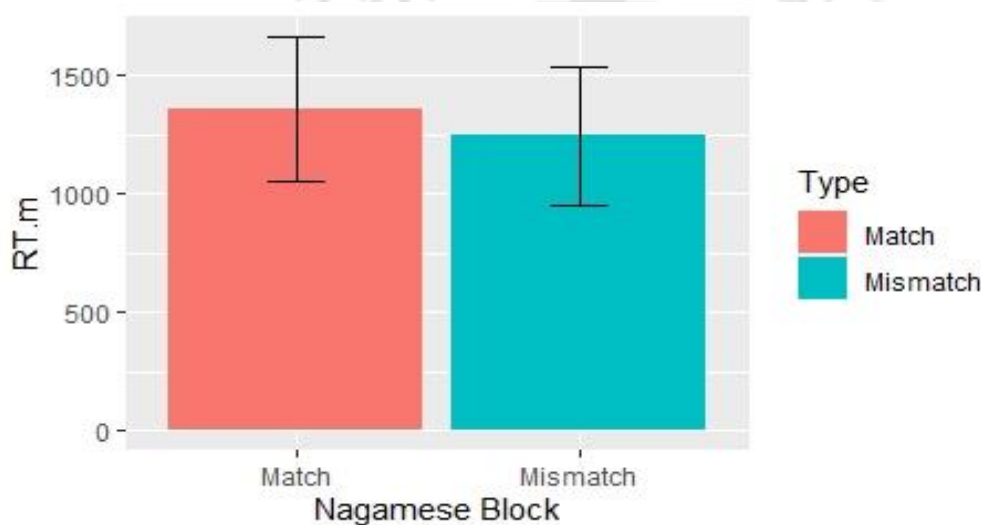


Figure 5.17. Mean RTs of the Types of Trials

The ANOVA results revealed that there was statistically significant difference between the two trial types,  $F(1, 2232)=84.14$ ,  $p<0.05$

In the error analysis also, statistically significant difference was found between the two trial types,  $F(1,106)=16.63$ ,  $p<0.05$ .

### Mixed Block

In the mixed block, reaction time was highest in Nagamese-Match trial ( $M=1334.42$ ,  $SD=272.47$ ) followed by Nagamese mismatch trials ( $M=1189$ ,  $SD=237.91$ ), English mismatch trial ( $M=1172.69$ ,  $SD=226.13$ ) and the lowest RT in English match trials ( $M=1056.70$ ,  $SD=232.44$ ). Table 5.15 presents the descriptive statistics of the mixed block.

Table 5.15. Descriptive Statistics

Language	Type	Mean	SD	SE
English	Match	1056.708	232.4415	6.801306
English	Mismatch	1172.693	226.1396	6.645417
Nagamese	Match	1334.425	272.4703	8.298695
Nagamese	Mismatch	1189.981	237.9154	7.009651

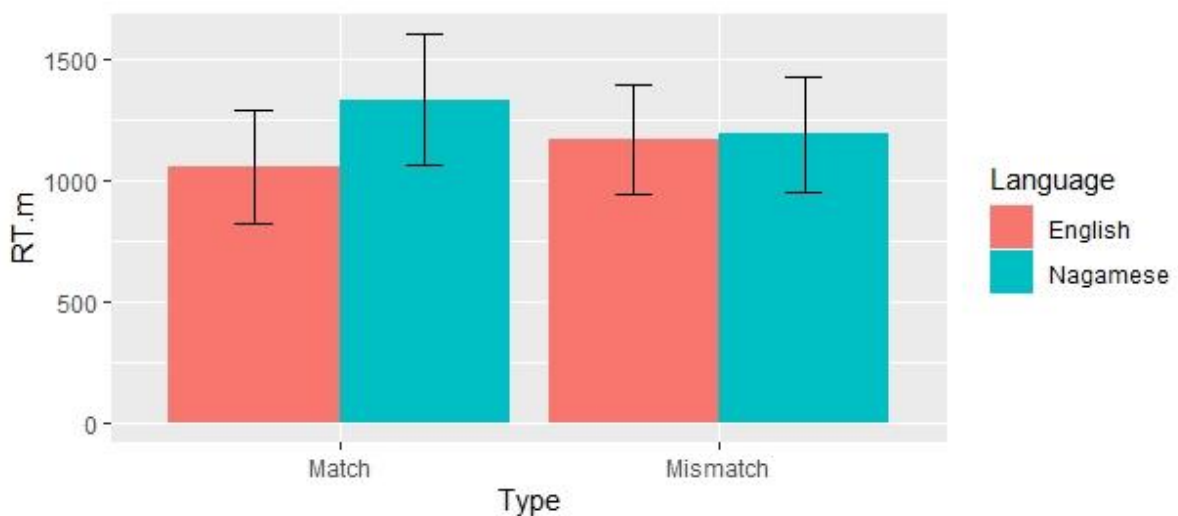


Figure 5.18. Mean RTs of the Types Across the Two Languages

In the mixed block, the Nagamese language had higher RTs as compared to the English language in both the match and mismatch types. However, there was no statistically significant difference between the Nagamese and English language and the match and mismatch types. In the Tukey's post hoc analysis also no significant difference was found.

In the error analysis, there was no significant difference between the English and Nagamese block,  $F(1, 133)=0.235, p=0.6287$ . But statistically significant difference was found between the match and mismatch trials,  $F(1, 133)=6.521, p=0.0118$ .

### Combined analysis

Table 5.16 gives the descriptive statistics of the three blocks, i.e., English, Nagamese and mixed block.

Table 5.16. Descriptive Statistics

Block	Language	Type	Mean	SD	SE
1	English	Match	1084.994	251.1838	7.472268
1	English	Mismatch	1233.166	273.7816	8.087457
2	Nagamese	Match	1359.527	304.6591	9.240585
2	Nagamese	Mismatch	1243.776	291.7877	8.615594
3	English	Match	1056.708	232.4415	6.801306
3	English	Mismatch	1172.693	226.1396	6.645417
3	Nagamese	Match	1334.425	272.4703	8.298695
3	Nagamese	Mismatch	1189.981	237.9154	7.009651

Figure 5.19 gives the reaction time of the blocks across trial types.

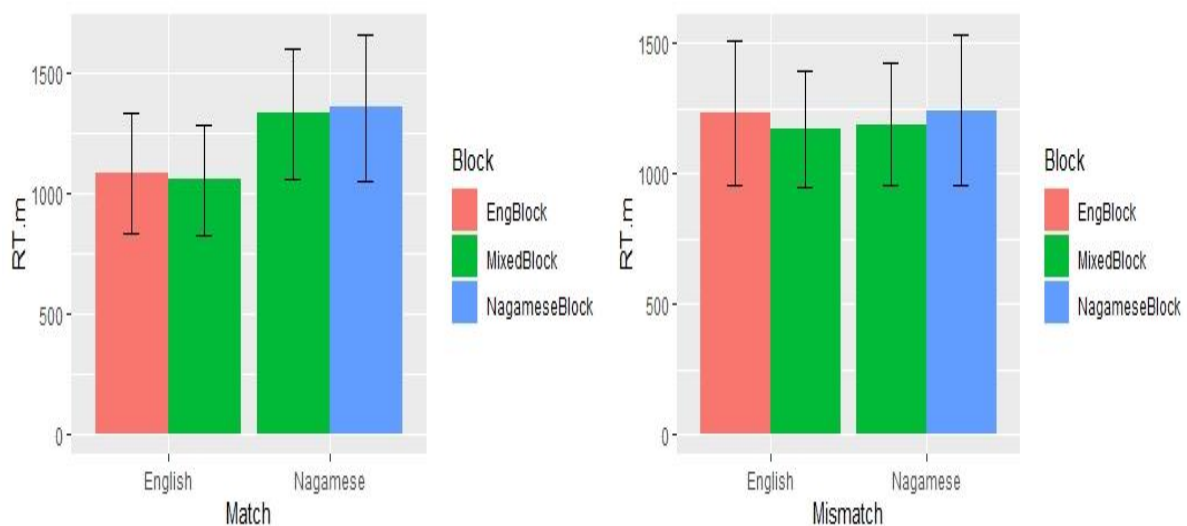


Figure 5.19. Mean RTs of Each Trial Types Across the Blocks

Table 5.19 provides the results of the combined analysis of the linear mixed model with RT as the dependent variable and trial type (match and mismatch), language (Nagamese and English) and their interactions as fixed effects. There was statistically significant difference between the blocks with higher RT in the Nagamese block by  $157.346ms$ ,  $SE=5.544$ ,  $t=28.380$ ,  $p<0.05$ . However, there was no difference between the trial types with higher RT in the mismatch trial type by  $2.99ms$ ,  $SE=5.299$ ,  $t=0.566$ ,  $p=0.572$ .

Table 5.17. Mixed effects model of RTs

Fixed effects	estimate	Std.Error	Df	t.value	p.value
Intercept	1191.191	19.915	39.988	59.814	<2e-16***
TypeMismatch	2.999	5.299	9033.150	0.566	0.572
LanguageNagamese	157.346	5.544	9033.117	28.380	<2e-16***
Block	-26.980	3.336	9033.154	-8.088	86e-16***

In the combined analysis, Nagamese block had an overall higher RT by *157.346ms* which was statistically significant,  $p > 0.05$ . Between the two types, mismatch type had overall higher RT by *2.999ms* but was statistically insignificant,  $p = 0.572$ . There was also statistically significant difference between the three blocks.

### Discussion

The aim of this experiment was to examine if the difference in the linguistic and social status of a language plays a role in bilingual language processing. From the results it is observed that the participants showed better performance in the Nagamese block as they incurred lesser processing cost in the mismatch type as compared to the match type. Whereas in the English block, the participants took higher RTs in the mismatch type. However, in the match type, the participants had higher RT in the Nagamese block. This means that the participants were faster at recognising the correct word-audio pair in the English block. The picture-audio match types of trials facilitated word recognition in the English block but was not observed in the Nagamese block as the mismatch type had shorter RT. In the mixed block, Nagamese language had overall higher RT with higher RT in the mismatch trials as compared to match trials. We also did a combined analysis which also revealed that overall Nagamese had higher RT. This means that the recognition of the picture-audio was poorer for Nagamese in general and better in English. Such a result could be due to many factors. As mentioned in the introduction, the linguistic and social status of the two languages is different with English having the higher status. Since Nagamese is not written, audio recognition was used and even then, the participants performed better in English. Thus, the status of English over Nagamese might have been a factor. The very concept of a research or experiment presents a formal setting which might have also primed the participants with English. Also, the participants were university students and hence English is used more predominantly than Nagamese in university setting. So, the environmental/social setting of the participants also plays the role.

The participants in the experiment were probably using English more than Nagamese or even their L1 on a day-to-day basis. Thus, in this case English becomes dominant than either Nagamese or their L1.

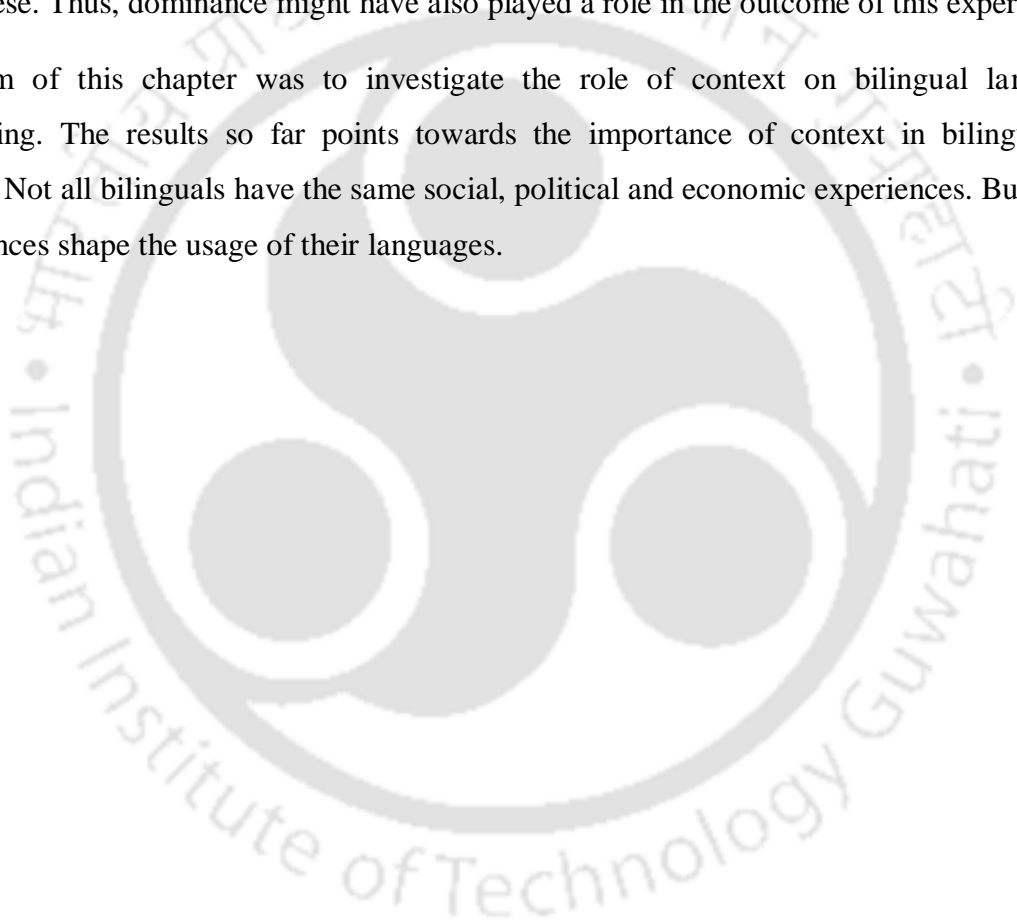
The statuses of the languages, context and dominance plays a role in the outcome of this experiment.

### **5.7. Summary of Findings and Discussion**

This chapter tried to look at the interactional context or linguistic context of bilinguals and see if it has an effect on the overall executive control and functions. In experiment 5,6 and 7, two group of bilinguals i.e., dual language context bilinguals and single language context bilinguals were examined in linguistic as well as non-linguistic task. In both linguistic and non-linguistic task, the results shows that the DLC participants performed faster than the SLC participants. The DLC participants incurred less switch cost than the SLC participants in the language switching comprehension task. They also incurred less interference cost by the incongruent condition in the ANT experiment and thus were able to respond faster as compared to the SLC participants. In the Simon task also, they were able to monitor more efficiently the conflict of the colour coded boxes and the spatial orientation and thus they were able to resolve the conflict faster resulting in overall faster reaction times. Thus, the results from the experiments involving the DLC and SLC participants show that the linguistic context of a bilingual plays a crucial role in bilingual language processing which in turn could affect overall cognitive control and processing. The DLC participants were bilinguals who somewhat maintained a balance use of both their languages (Ao and English) as compared to the SLC participants who kept their two languages separate and hardly used the second language at home. The DLC participants exhibited advantages over the SLC participants across all the three experiments. This shows that the context of the DLC participants enhances efficiency conflict monitoring and taking advantage of cues in both linguistic and non-linguistic task. This finding is also in line with previous studies that show that balance bilinguals showed less switch cost (Guerrero et al., 2015) and faster in Stroop and delay-gratification task (Verhagen et al., 2015). In experiment 4, two languages, both non-L1 but with different linguistic and social statuses was examined. In this experiment also it was found that the context of the bilinguals plays a major role in language processing. This experiment explored the social status held by the two languages under examination and the

results indicated that the perception of the language by the people is very important while studying bilingualism. Because Nagamese is considered only as a trade language and a medium of communication, it is lower in hierarchy as compared to English which is considered as a language of the higher and educated society. Thus, this perception of the languages played a role in the performance in this experiment. The participants might have subconsciously repressed Nagamese specially when it is presented in a mixed setting with English resulting in higher reaction times in Nagamese recognition as compared to English recognition. Another point to consider is that English is the primary language for most university students and so English becomes the dominant language as compared to Nagamese. Thus, dominance might have also played a role in the outcome of this experiment.

The aim of this chapter was to investigate the role of context on bilingual language processing. The results so far points towards the importance of context in bilingualism studies. Not all bilinguals have the same social, political and economic experiences. But these experiences shape the usage of their languages.



## CHAPTER 6: CONCLUSION



## 6.1. Introduction

Bilingualism is one of the most debated and controversial phenomena discussed since the late 20<sup>th</sup> century. While some researchers have found immense amount of evidence for a positive impact of bilingualism on cognitive abilities (Bialystok et al., 2005; Bialystok et al., 2007; Costa et al., 2008; Alladi et al., 2013; Bak et al., 2014), others have found no such effect (Paap & Greenberg, 2010; Sanders et al., 2012). Within bilingualism research, studies looking into the effect of bilingual language experience and context have gained momentum in the last few decades. Bilingualism is a dynamic and complex phenomenon (Bak, 2016) and it is affected by many factors including but not limited to cultural and linguistic environment. The ability to juggle two or more languages, activating the target language and inhibiting the non-target languages requires a lot of control. So how does a bilingual know which language to activate and which language to inhibit? It has been found that external non-linguistic cues like culturally iconic images and faces (Woumans et al., 2015; Zhang et al., 2013; Jared et al., 2013; Roychoudhuri et al., 2016; Liu et al., 2021) and also the interactional context (Hartanto & Yang, 2016) of the bilinguals aid in language selection and processing. Both factors have been found to impact language control which in turn effect cognitive control. Another important thing to be noted here is that most of the research on the role of culture on language processing has mostly focused on immigrant populations with vast difference in their L1 and L2 and as well as the two cultures. Outside the western countries, most population are bilinguals and it's a natural and common part of everyday life. Thus, in these populations, bilingualism is not associated with immigration and subscription to a certain ethnic group. Similarly for research on the role of interactional context on bilingual language processing, most studies have been reported from western countries and lacks evidence from places like Asian countries where multilingualism is the norm and there is fluidity at the social and cultural level, often leading to biculturalism and they often exhibit language switching. Therefore, mechanisms involved in language processing might be different for such groups of population. All these points to a need to examine such populations to fully understand the workings of the bilingual brain.

The main aim of the thesis thus was to examine the role of culture and interactional context in bilingual language processing with a focus on less studied population. This thesis is one of the first attempts to study the role of culture and interactional context in language processing in Northeast India where various cultures reside side by side and where bilingualism is the norm and not an exception. The thesis brings in some insights as the studies compared

various groups of bilinguals in terms of age, geographical setting, educational level and socio-cultural context. The thesis also gives a comparison between immigrant and non-immigrant population and university student and non-university student. In the next sections, the summaries of the findings from the experiments are given.

## 6.2. Findings from the Experiments

Table 6.1 summarizes the findings from each of the experiments.

*Table 6.1. Summary of All Experiments, Participants, Tasks and Findings*

Experiments	Participants	Task	Findings
1. Culturally related cue (dress) as stimuli	Group 1: 27 Rongmei-Meitei bilinguals, age 18-33years Group 2: 27 Rongmei-Meitei bilinguals, age 40-59 years	Translation equivalent word recognition task	Main effect of the incongruent condition was not found No interaction between the conditions and group Language direction turned out to be an important predictor of response latency
2. Culturally related cue (dress) as stimuli	40 Sangtam-Ao 40 Ao-Sangtam Age 25-45 years	Translation equivalent word recognition task	Effect of the incongruent condition was not seen There was no switch cost
3.	Same participants as exp. 2	Flanker task	Flanker effect was seen in both groups
4. Culturally related cue (food) as stimuli	20 Ao-English age 21-30years	Lexical Decision Task	Interference by L2 image in L1 processing was observed Juxtaposes the findings from exp 1 & 2
5.	20 DLC 21 SLC age 21-30 years	LEAP-Q Lextale test Lexical decision task	No difference in response latency between SLC and DLC was observed SLC participants error rate was higher
6.	Same participants as exp 5	ANT	Lesser RT observed in spatial cue type for both groups

			Effect of the incongruent condition was seen in both groups Overall, SLC participants had higher RT
7.	Same participants as exp 5 & 6	Simon task	Shorter RT observed in the DLC group More efficient conflict monitoring in DLC
8.	20 participants age 20-40 years	Nagamese-English Picture-audio recognition task	Better performance in the Nagamese block as less processing cost was observed in mismatch type Faster at recognizing match type in English block In the mixed block, Nagamese had overall higher RT

Through the experiment conducted for the thesis, this study tried to investigate and answer some of the questions and theoretical frameworks introduced in chapter 1 & 2. In experiments 1, 2, 3 and 4, the role of culture was investigated on bilingual language processing by manipulating iconic culture cues as stimuli for the experiments. The first thing that the study tried to explore was whether the findings from the experiments corroborate the previous findings from non-WEIRD population i.e., interference and inhibition due to mismatched culture cue. Experiments 1 and 2 did not provide any evidence for such an effect as no effect of the incongruent condition was observed. This finding is contradictory to other findings with reported effect of interference by the culture cue (Zhang et al., 2013; Jared et al., 2013; Roychoudhuri et al., 2016; Liu et al, 2019). Furthermore, the effect of urban/rural, educated/non-educated and old/young was not seen from the results as no difference between the groups was observed in this regard. However, the direction of the language turned out to be an important predictor in bilingual language processing. The congruency effect was however observed in experiment 3 and 4. Experiment 3 was a non-linguistic task, i.e.,

Flanker task and there was higher reaction time observed in Ao-Sangtam as well as Sangtam-Ao group. This means that there was a flanker effect in both the groups. Experiment 4 was specially designed to juxtapose experiment 1 and 2. In this experiment, the participants were migrant population living in L2 dominant linguistic and cultural environment. This group of participants resembled the usual participants mentioned in most of the previous studies in the literature, i.e. students, living away from their home, often in L2 dominant environment (Jared et al., 2013; Roychoudhuri et al., 2016). In this experiment evidence of L2 image affecting L1 processing was observed, which is in line with previous findings. Thus, these findings and observations point towards the issues raised in chapter 1 and 2 that distinct bilingual experiences might influence language processing differently. The findings from these experiments also lends support towards ACH and the importance of context in bilingual language processing.

Experiments 5, 6, 7 and 8 tried to investigate the role of bilingual interactional context on bilingual language processing in general and specifically executive control. As predicted by the ACH, it was expected that the intensity of demands in the DLC interactional context would modulate language control. But experiment 5 did not provide any evidence of DLC advantage as response latency was similar for both DLC and SLC participants. In experiment 6, the effect of the incongruent condition was seen in both groups but the SLC group had overall higher RT. Together with experiment 7, where higher RT was again observed in the SLC group, the findings provide strong evidence for DLC advantage. The tasks in this experience were response inhibition tasks and the observed efficiency in conflict monitoring in the DLC participants point towards the modulating effect of bilingual interactional context on language control processes which in turn could modulate cognitive control. This finding is in line with previous studies (Hartanto & Yang, 2016; Henrard & van Daele, 2017; Verreyt et al., 2015; Ooi et al., 2018) and gives support to the ACH.

### **6.3. Implications of Findings**

One of the crucial gaps in the literature and previous findings was that most of the research on bilingual language processing are from WEIRD countries and do not account for the multifaceted distinct bilingual experiences outside of the western countries. Thus, this study tried to explore this gap in the literature by conducting experiments with non-WEIRD population. The findings from the study is interesting as most of the findings did not

corroborate the findings from previous research specially in the role of culture cues in bilingual language processing. The findings suggest that in populations where bilingualism and biculturalism is a part of everyday life, the effect of culture on language processing may not be visible, or at least become harder to detect as cues such as culture becomes unimportant or less salient in interactions in these types of populations. Culture cues may act as a salient feature only in languages and cultures that are distant or has vast differences like the findings from the Ao-English population in experiment 4. This is true of previous findings as well, like in studies involving the Chinese-English bilinguals. These findings highlight the importance of taking into account the number of variables, interacting with cultural affinity, that might affect language processing and not just culture as a homogenous entity.

Another important factor investigated in this study was the role of interactional context on bilingual language processing. Even though we saw the DLC advantage in experiments 6 and 7, such an effect was not seen in experiment 5 as the DLC and SLC participants showed similar performance. This poses the question as to what extent the interactional context affects control in general. Experiment 5 was a linguistic task and as such the DLC participants should have exhibited faster response time as predicted by the ACH. However, the modulating effect of the interactional context was seen only in experiment 6 and 7, which were non-linguistic response inhibition task. Therefore, the findings from the study suggest that the functioning of domain general and domain specific regions might be different as the effect of the demands of the interactional context on language specific task was not seen. This needs further probing with neuroimaging studies to truly understand the computations carried out by the different regions of the brain especially in terms of language control and executive function, using this variable. In experiment 8, the role of relative social status of second and third languages in language processing was investigated. As expected, the participants incurred higher reaction time in the Nagamese recognition as compared to English. The higher status of English resulted in higher activation of English leading to shorter reaction time. This is particularly interesting because Nagamese, being a lingua franca, is used heavily in various everyday scenario whereas English is used for more formal domain by the same population. This finding only cements the idea of taking into consideration the social, economic and linguistic background of the bilinguals in research.

Recent theoretical frameworks like the ACH have come up to highlight the importance of context while studying bilingual language processing. Therefore, the study posits a base to

continue this important line of investigation of taking into account the distinct bilingual experiences and the non-WEIRD population. There is no doubt that the culture and interactional context of the bilinguals do have an effect on language processing. But to what extent and more crucially it remains to be seen if such effects can be generalized for bilinguals in bicultural bilingual/multilingual societies.

#### **6.4. Some Problems**

The main problem faced as far as methods used in the study was the use of computer for data collection. Specifically, the participants in experiment 1 and 2 belonged to older age group and most of them were not used to computers in their everyday life and so there is the possibility that the lack of familiarity with the interface might have affected the response latency, even if to a small extent. The group was given a training session before the main experiment. Since it was important to investigate the difference in terms of age as well as the socio-cultural setting, data collection had to be done in areas where fluidity of language and culture is a norm. The participants in the other experiments did not face such problems as they were mostly students familiar with the interface. A similar problem would be faced if we are to conduct neuroimaging studies. While university student participants are easy and accessible, they don't really represent the multifaceted nature of bilingualism that exist outside of campus. In future, more innovative data collection methods may take these into account and come up with some 'natural' ways to tackle this issue. It can never be overemphasized that the field needs input from people and groups outside the usual 'mainstream', 'modern' pool of participants studied in laboratories.

#### **6.5. Limitations**

The experiments on the effects of culture cue provides strong evidence for the importance of bilingual context in bilingual language processing research as the results in this study contradicted findings from previous studies. This could have a strong impact on the way we look at bilingualism i.e., through the lens of western culture and perception. However, one of the main weaknesses of the study was that data from more groups of bilinguals and cultures couldn't be included. As discussed before, India is rich in diversity, be it culture or language. So, while the findings from this study shed new light in the research area, it does not

necessarily generalize the whole country or bicultural or multilingual or bilingual communities around the world. Though there have been some recent findings in the same line as the findings from this study, this needs to be further explored and investigated to come to a concrete conclusion.

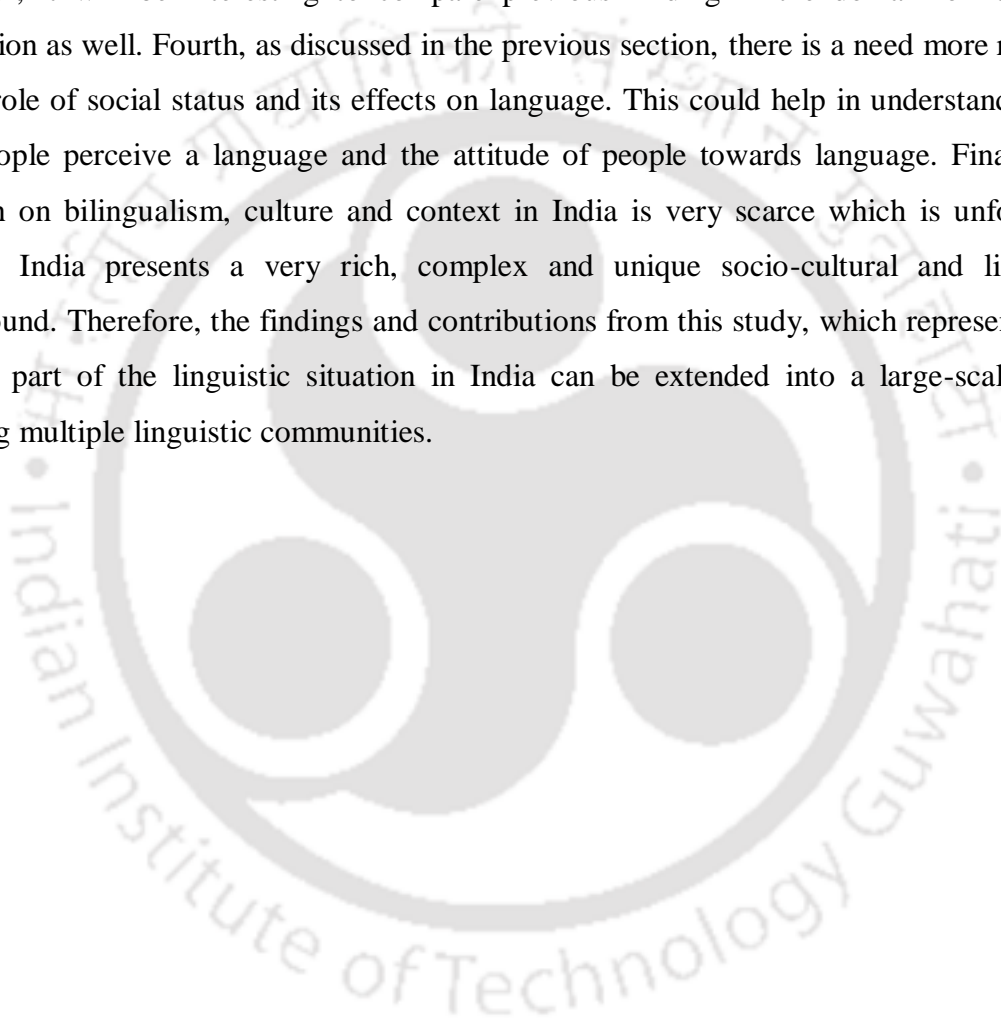
On the effects of the interactional context, this study looked at two types of language context, i.e., the single language context and the dual language context as proposed by the ACH. This was done intentionally, partly to check the difference between these two groups. The plan to include the dense code-switching context had to be dropped due to various constraints, like that of travel, mainly arising out of COVID. It will be interesting to see if the dense code-switching context could also match up to the predictions of the ACH. Similarly, this study could explore the role of social status in only one experiment. But we are aware that there are also other language pairs, like Nagamese and English, that share a similar hierarchical relationship in northeast India and other parts of India as well. Research in this area could contribute a lot in language teaching, awareness and preservation of regional languages and mother tongues.

## **6.6. Future Directions**

The findings from this study shed new light in the field on bilingual language processing, language control and cognitive control. Although the study used only behavioral techniques, the results from the experiments provides evidence for the importance of context on bilingual language processing, be it cultural context or interactional context. The findings from the culture cue experiments are contradictory to the literature since we did not find evidence for the effect of culture in language comprehension. Similarly, with the interactional context experiments, we found the modulating effect of the interactional context only in non-linguistic task. This is in line with previous findings but more work is needed to truly understand the effects in all their finer aspects. The findings of this study could prove to be the basis of further studies on these questions, using non-behavioral methods.

Over the course of the study, more questions arose but they could not be investigated due to time constraints. First, the methods used in the experiments were behavioral techniques and while the experiments did yield very interesting and new evidences, it would be wise to further investigate this line of study with neuroimaging and eye tracking techniques. Second, the experiments for the culture cue studies were novel in the sense that the participants

belonged to non-WEIRD, bilingual bicultural population. Thus, they are more representative of the actual everyday complex bilingualism practiced by majority of the population across the world. Therefore, it is our intention to further investigate the different types of bilingualism practiced in such communities and further contribute to the ever-growing body of work in bilingualism research. Third, as discussed in chapter 1, language processing includes both language production as well as comprehension. In this study, only the domain of language comprehension was investigated as there is a lack of literature in that domain. However, it will be interesting to compare previous finding in the domain of language production as well. Fourth, as discussed in the previous section, there is a need more research on the role of social status and its effects on language. This could help in understanding the way people perceive a language and the attitude of people towards language. Finally, the research on bilingualism, culture and context in India is very scarce which is unfortunate because India presents a very rich, complex and unique socio-cultural and linguistic background. Therefore, the findings and contributions from this study, which represents only a small part of the linguistic situation in India can be extended into a large-scale study covering multiple linguistic communities.



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## Appendices

### Appendix A

#### *Language background questionnaire*

**Participant:**

**Date:**

#### **I. Personal Data**

1. Name :

2. Age :

Date Of Birth :

Gender :

#### **II. Family History**

3. Where are your parents/caregivers from?

Mother: \_\_\_\_\_

Father: \_\_\_\_\_

4. What languages do your parents/caregivers speak?

Mother: \_\_\_\_\_

Father: \_\_\_\_\_

#### **III. Your Linguistic History**

5. At what age did you first begin to learn Rongmei?



Daily      Every Alternate Day      Once a week

(c) Is there an L1 newspaper?

Yes      No

(d) If yes, how often do you read it?

Daily    Every Alternate Day    Once a Week

11. (a) Do you listen to Radio in your first language?

Yes      No

(b) How often do you read the L1 newspaper?

Daily    Every Alternate Day    Once a Week

#### V. Your linguistic proficiency now

12. List all languages you know in order of most proficient to least proficient. Rate your ability on the following aspects in each language. Please rate according to the following scale (write down the number in the table):

**Scale:**

Very poor      Poor      Fair      Functional      Good      Very good      Native-like

1 \_\_\_\_\_ 2 \_\_\_\_\_ 3 \_\_\_\_\_ 4 \_\_\_\_\_ 5 \_\_\_\_\_ 6 \_\_\_\_\_ 7 \_\_\_\_\_

Language	Reading proficiency	Writing proficiency	Speaking fluency	Listening ability

13. On a scale from 1 to 5, rate the extent to which you identify with Rongmei and Meitei culture

(1 =no identification; 2= very low identification; 3=Moderate identification; 4= high identification; 5= complete identification)

Rongmei Culture=

Meitei Culture=

**VI. Notes:**

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## Appendix B

### Questionnaire adapted from Language Experience And Proficiency Questionnaire (LEAP-Q)

1. Name: \_\_\_\_\_ 2. Age: \_\_\_\_\_ 3. Date of birth: \_\_\_\_\_

4. Gender: \_\_\_\_\_

5. Please list all the languages you know in order of dominance

1.	2.	3.	4.	5.
----	----	----	----	----

6. Please list all the languages you know in order of acquisition (your native language first).

1.	2.	3.	4.	5.
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7. Please list what percentage of the time you are currently and on average exposed to each language. (Your percentage should add up to 100)

Language					
Percentage					

8. How many years of formal education do you have? \_\_\_\_\_ Please check your highest educational level

- None
- Till class 5
- Till class 10
- Till class 12
- College (Graduation ongoing)
- College (Graduation completed)
- Post-graduation (Master's ongoing)
- Post-graduation (Master's complete)
- PhD (Ongoing)
- PhD (Complete)

9. Have you ever had a vision problem\_\_\_\_, hearing impairment\_\_\_\_, language disability\_\_\_\_, or learning disability\_\_\_\_? (Check all applicable). If yes, please explain, (including all corrections): \_\_\_\_\_

10. Are you currently working? \_\_\_\_\_

If yes, then how many years? \_\_\_\_\_

11. List out the languages you currently know (even if it is a few words or broken sentence structures you picked up while watching the latest K-drama, mention them). Mark the box if you have the reading, writing, speaking and listening skills for that language.

Language	Listening	Speaking	Reading	Writing
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. For the languages listed above, state the age at which you started using the language for listening, speaking, reading and writing. Then state the total number of years of usage for each language. (For years of usage, even if you have stopped using the language for some time and then started again, give the total number of accumulative years)

Language	Listening	Speaking	Reading	Writing	Years of usage

13. In each of the languages you have mentioned before, rate your listening, speaking, reading and writing abilities on a scale of 1-7.

1- Very Poor; 2- Poor; 3- Limited; 4- Average; 5- Good; 6- Very Good; 7- Excellent

Language	Listening	Speaking	Reading	Writing

14. What is your region of origin? \_\_\_\_\_

15. a. What is your current region of residence? \_\_\_\_\_

b. How many years spent in the current region? \_\_\_\_\_

16. Have you travelled to, and then stayed, in a different region within the past three months?

- Yes
- No

17. If yes, then state the language(s) you have used there in the duration and the frequency of its usage.

1- Never; 2- Rarely; 3- Sometimes; 4- Regularly; 5- Often; 6- Usually; 7- Always

Region	Length of stay (days)	Language	Frequency of use (1-7)

18. Indicate the manner in which you acquired your non-native languages.

(immersion: living in a community and learning the language through submersion in that language environment)

Non-native language	Immersion	Classroom instruction	Self-learning
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

19. At each educational level, what was the language used as a medium of instruction by your teachers? If the language used was switched during that time, also mention the 'Switched to' languages and check the box for 'Multiple languages'.

Educational level	Language	Switched to	Multiple languages
Till class 5			<input type="checkbox"/>
Till class 10			<input type="checkbox"/>
Till class 12			<input type="checkbox"/>
College (Bachelor's)			<input type="checkbox"/>
College (Master's)			<input type="checkbox"/>
PhD			<input type="checkbox"/>

20. Rate your ability to learn languages. How good do you think you are at picking up language skills?

- 1 (Very poor)
- 2 (Poor)
- 3 (Limited)
- 4 (Average)
- 5 (Good)
- 6 (Very good)
- 7 (Excellent)

21. Which language do you feel you communicate best in or are most comfortable with in terms of listening, speaking, reading and writing? Mention the language in the box below. It can be the same for all situations. [Please note, school here can mean institute, college, etc. whichever educational level you are currently in]

	Listening	Speaking	Reading	Writing
At home				
With friends				
At school				
At work				

22. On a scale of 1-7, how often do you use each of the languages you have mentioned for the following activities?

1- Never; 2- Rarely; 3- Sometimes; 4- Regularly; 5- Often; 6- Usually; 7- Always

[\*includes shouting, cursing affection, etc.      \*\*counting, calculating, etc.      \*\*\*telephone numbers, ID numbers, etc.]

Language	Thinking	Talking to self	*Expressing emotions	Dreaming	**Arithmetic	***Remembering numbers	Praying

23. Comment below if you have any additional information to the questions asked above related to your language usage and background. Anything that you feel might help.

## Appendix C

### Revised Bilingual interactional questionnaire on language usage and switching pattern

Instructions:

Each section has a separate question. There are 5 questions in all. You have to answer your language switching tendencies in different scenarios. Please make sure that your answers in each page add up to a 100. You can use a 0 (zero) if a scenario is not applicable to you. However, the total in every page has to add up to 100%

Please use the same participant number you have been using for the previous questionnaires and experiment.

1. Participant number:

How much time do you spend in each of the following situations, in a day? Note that your answers *should add up to 100*.

1. Home:
2. Educational Institutions (including online classes):
3. Social Interactions (includes talking to friends, neighbours. Can include face to face interactions or talking on the phone):
4. Non-social interactions (includes shop vendors, cab drivers etc):

Home

1. Name the languages you use most often at home.

- a.
- b.

2. What is the percentage of your language switching tendency at home? You will be given 3 possibilities. *The total percentage of the three answers should add up to 100%*. Please read the possible answers carefully.

- a. I speak only one language and rarely switch to the other languages at home
- b. I speak two (or more) languages when I converse with different speakers at home. I often switch languages but rarely mix languages within a sentence.
- c. I routinely mix two (or more) languages within a sentence to most speakers at home.

#### Educational Institutions

1.Name the languages you use most often in educational institutions.

- a.
- b.

2.What is the percentage of your language switching tendency at **educational institutions**? You will be given 3 possibilities. *The total percentage of the three possibilities should add up to 100%*. Please read the possible answers carefully.

- a. I speak only one language and rarely switch to the other language at school/college/University (including online classes).
- b. I speak 2 (or more) languages when I converse with different speakers during classes. I often switch languages but rarely mix languages within a sentence.
- c. I routinely mix 2 (or more) languages within a sentence to most speakers during classes

#### Social Interactions

1.Name the languages you use most for social interactions

- a.
- b.

2.What is the percentage of your language switching tendency during your **social interactions**\*? You will be given 3 possibilities. *The total percentage of the three possibilities should add up to 100%*. Please read the possible answers carefully.

\*(includes talking to friends, neighbours. Can include face to face interactions or talking on the phone)

a. I speak only one language and rarely switch to the other language during a social interaction.

b. I speak 2 (or more) languages when I converse with different speakers in a social interaction. I often switch languages but rarely mix languages within a sentence.

c. I routinely mix 2 (or more) languages within a sentence to most speakers in a social interaction.

#### Non-Social Interactions

1. Name the languages you use for social interactions

a.

b.

2. What is the percentage of your language switching tendency during your **non-social interactions**? You will be given 3 possibilities. *The total percentage of the three possibilities should add up to 100%. Please read the possible answers carefully.*

\*(includes shop vendors, cab drivers, etc.)

a. I speak only one language and rarely switch to the other language during a non-social interaction.

b. I speak 2 (or more) languages when I converse with different speakers during a non-social interaction. I often switch languages but rarely mix languages within a sentence.

c. I routinely mix 2 (or more) languages within an utterance to most speakers in a non-social interaction.

## Appendix D

### Formula for the indices of each type of bilingual interactional context

1. Single language context index =  $\sum_{i=4}^4 \frac{pi \times sli}{100}$

2. Dual language context index =  $\sum_{i=4}^4 \frac{pi \times dli}{100}$

3. Dense code switching context index =  $\sum_{i=4}^4 \frac{pi \times dci}{100}$

Note:  $pi$  denotes the amount of time spent in each situation like home, school etc,  $sli$  denotes the percentage of a single language context within a given situation,  $dli$  denotes the percentage of a dual language context within a given situation and  $dci$  denotes the percentage of dense code switching in a given situation.

## **Appendix E**

### **Consent to Participate in a Research Study**

#### **Description of the research and your participation**

You are invited to participate in a research study conducted by Opangienla Kechu, Research scholar, HSS department, IITG. This research is on bilingual language processing involving Ao and Sangtam languages. This is part of a Ph.D research work carried out in Indian Institute of Technology, Guwahati in Language and Cognition lab.

Your participation will involve filling up a language background questionnaire and taking part in a computerized analysis of the two languages.

#### **Risks and discomforts**

There are no known risks associated with this research.

#### **Protection of confidentiality**

All information collected: responses and participants' language history background will be kept strictly confidential and not be revealed under any condition without the permission of the participant.

#### **Voluntary participation**

Participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study.

#### **Contact information**

If you have any questions or concerns about this study or if any problems arise, please contact Opangienla Kechu, HSS department, IITG. If you have any questions or concerns about your rights as a research participant, please contact Research and Development section, Indian Institute of Technology, Guwahati.

#### **Consent**







**I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.**

Participant's signature \_\_\_\_\_ Date: \_\_\_\_\_



## Appendix F

### Culture cues used in experiment 1

Condition	Images	
Congruent		
Incongruent		
Neutral		

## Appendix G

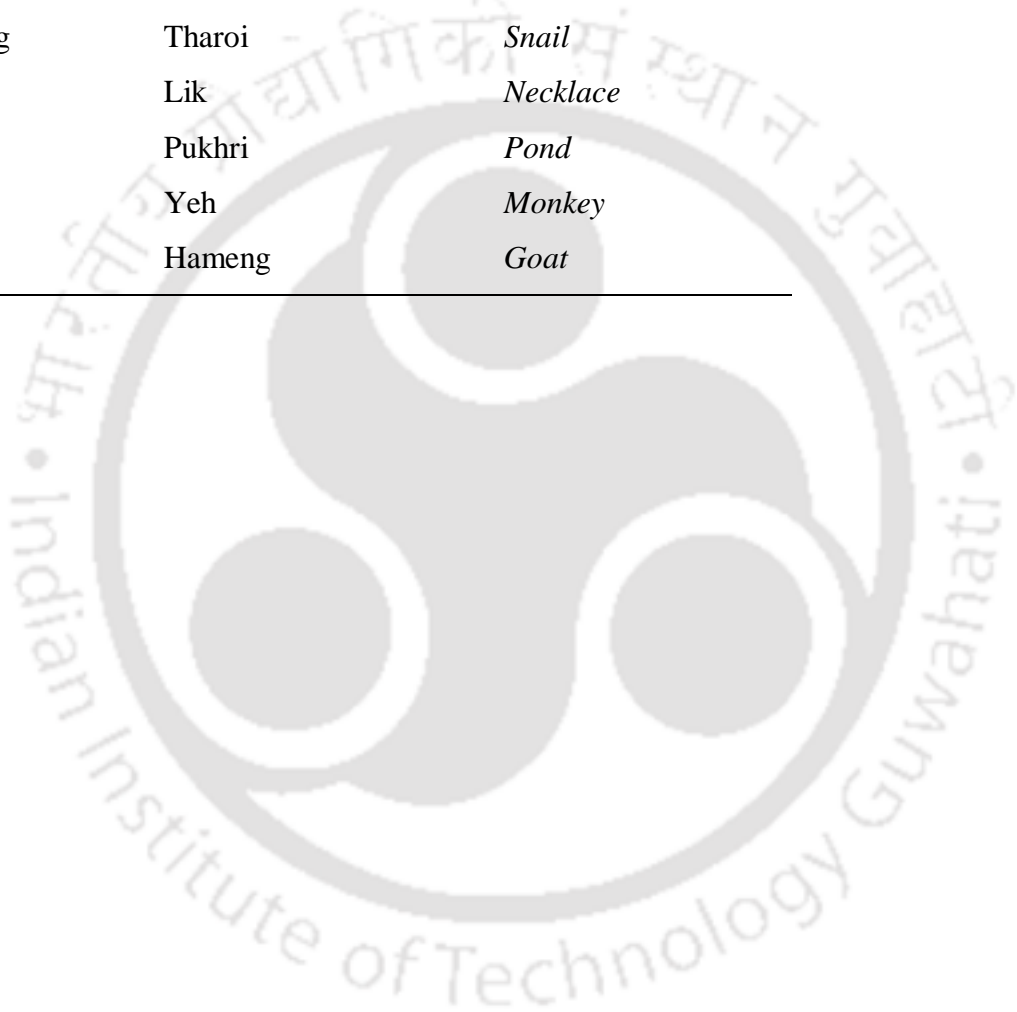
### Translation equivalents used in experiment 1

Rongmei	Meitei	Meaning
Baeng	Thang	<i>Knife</i>
Baengkhuai	Thangon	<i>Sickle</i>
Bahthai	Heinou	<i>Mango</i>
Bamsaengh	Phan	<i>Bench</i>
Dunghbamv	Choukri	<i>Chair</i>
Gannamv	Chanam	<i>Garlic</i>
Gat	Thinpa	<i>Leech</i>
Gou	Hangoi	<i>Frog</i>
Guaih	Sanh	<i>Cow</i>
Guak	Oak	<i>Pig</i>
Kai	Yum	<i>House</i>
Kailaek	Keirak	<i>Ladder</i>
Kamang	Kei	<i>Tiger</i>
Khav	Nga	<i>Fish</i>
Laeng	Phamung	<i>Bed</i>
Luanghkamang	Nongsha	<i>Lion</i>
Mairam	Thonmai	<i>Torch</i>
Miauna	Houdong	<i>Cat</i>
Nahwam	Chuzak	<i>Maize</i>
Patuanathai	Pungthon	<i>Guava</i>
Phwm	Nganu	<i>Duck</i>
Phyna	Khunu	<i>Pigeon</i>
Pinh	Yetum	<i>Needle</i>
Puak	Uchi	<i>Rat</i>
Pungma	Mairen	<i>Pumpkin</i>
Rih	Sinjang	<i>Axe</i>
Ruaykui	Yenbi	<i>Hen</i>

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Rui	Lin	<i>Snake</i>
Sanh	Saji	<i>Deer</i>
Senamathai	Chumbrei	<i>Apricot</i>
Si	Hui	<i>Dog</i>
Talemv	Kurak	<i>Butterfly</i>
Tamal	Nongmei	<i>Gun</i>
Tamlinghna	Chum	<i>Lizard</i>
Tandiak	Nungthang	<i>Hammer</i>
Tanyang	Tharoi	<i>Snail</i>
Tuh	Lik	<i>Necklace</i>
Zeih	Pukhri	<i>Pond</i>
Zouc	Yeh	<i>Monkey</i>
Zuih	Hameng	<i>Goat</i>

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## Appendix H

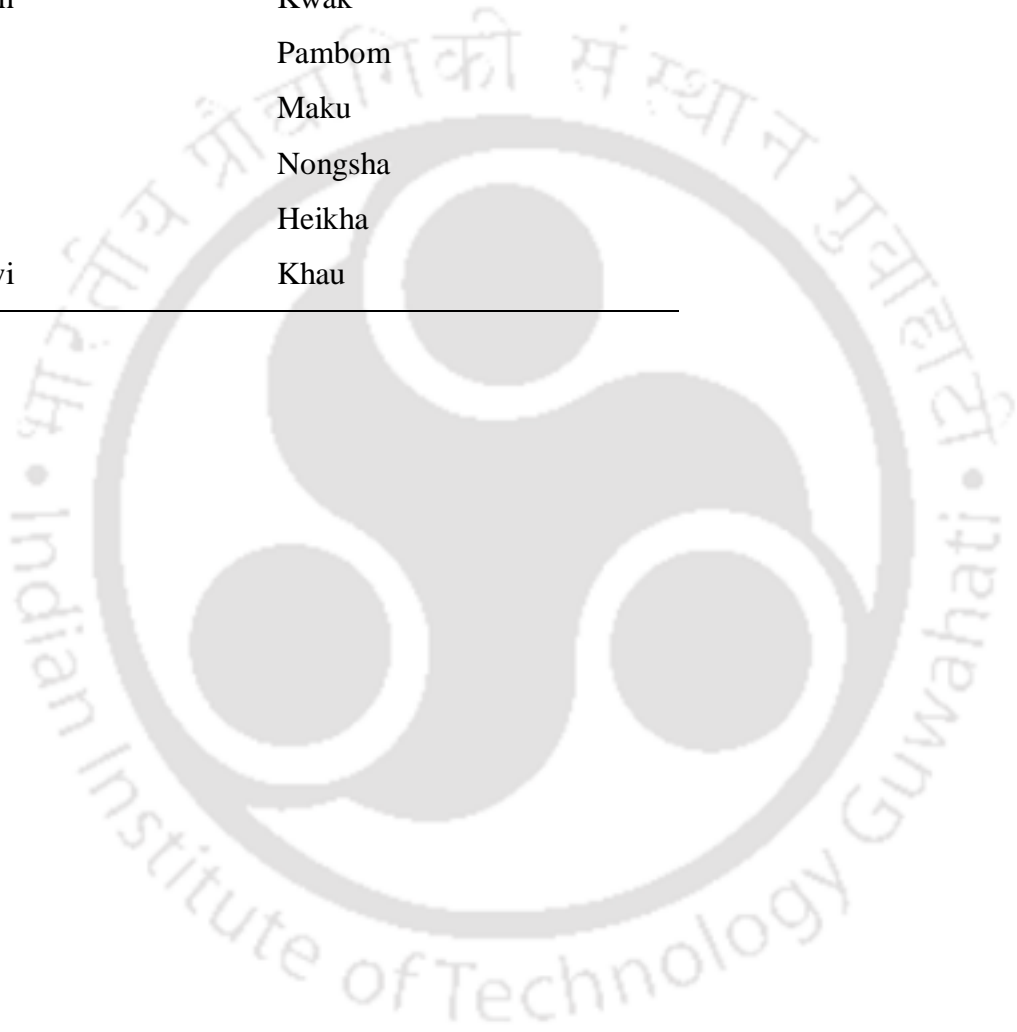
### Non-Translation equivalents used in experiment 1

Rongmei	Meitei
Agaek	Morok
Baengsaeng	Hangoi
Baley	Uhei
Buak	Thengu
Chei	Kabrangchak
Chiat	Haying
Guaihlwaih	Kaojing
Guali	Kang
Guh	Khamen
Huh	Lam-oak
Kabut	Nupi Macha
Kamai	Laphoi
Kangc	Hameng
Khaeu	Angang
Khahtang	Mangra
Khuangh	Hawaijar
Khubut	Chumbrei
Khuk	Tha
Mangge	Saji
Muangh	Fadigom
Mwang	Sitaphol
Nay	Kheirai
Ngumrou	Sabou
Nuy	Awa-thabi
Paanv	Kamphoi
Pareiriang	Oak
Phayzung	Sem
Phu	Nganu

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Rik	Kharmi
Rou	Khunu
Rudeipui	Yu
Sanh	Saji
Satin	Chum
Swkaeng	Soomchit
Tariangh	Amotpa
Tariangh	Kwak
Thai	Pambom
Tiang	Maku
Toudai	Nongsha
Zanhtei	Heikha
Zungkwi	Khau

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## Appendix I

### Culture cues used in experiment 2

Condition	Images
Ao iconic cultural dress	
Sangtam iconic cultural dress	
Neutral cues	

## Appendix J

### Translation equivalents used in experiment 2

Ao	Sangtam	Meaning
Somomo	Lalümsih	<i>Banana</i>
Langpang	Yüpji	<i>Bed</i>
Ninang	Thsah	<i>Bee</i>
Menden	Pümji	<i>Bench</i>
Rong	Kihtang	<i>Boat</i>
Teret	Arüh	<i>Bone</i>
Kaket	Vakha	<i>Book</i>
Tekolok	Thoh	<i>Brain</i>
Jang	Nyürü	<i>Buffalo</i>
Tanü	Kuh	<i>Cat</i>
Kumesü	Küsü	<i>Comb</i>
Nashi	Misüh	<i>Cow</i>
Tsüngen	Shühkong	<i>Crab</i>
Waro	Khühyala	<i>Crow</i>
Mepet	Nyükh	<i>Cloud</i>
Züngi	Nushah	<i>Cucumber</i>
Marok	Shing	<i>Cup</i>
Mesü	Shümüshü	<i>Deer</i>
Azu	Fühza	<i>Dog</i>
Batak	Kihvi Hüna	<i>Duck</i>
Nhar	Nang	<i>Earring</i>
Tezüng	Anpüh	<i>Feather</i>
Ango	Nguh	<i>Fish</i>
Naro	Yungpi	<i>Flower</i>
Temübu	Amüpha	<i>Feet</i>
Napong	Mihza	<i>Goat</i>
Apu	Lopa	<i>Ladder</i>
Molusüngzü	Kihkhünying	<i>Lion</i>
Menti	Tsesu	<i>Maize</i>
Godoro	Nganyi	<i>Pigeon</i>

## Appendix K



### Non-Translation equivalents used in experiment 2

Ao	Sangtam
Aoso	Kongru
Mapu	Lah
Koya	Jingkhum
Lisü	Bhophu
Tsungsem	Shüka
Ninok	Shirung
Per	Kheng
Anü	Lasing
Tepu	Sheng
Kiyi	Uza
Temeli	Dsangsi
Anüshi	Anük
Tashikang	Thsalu
Sangken	Küwa
Konger	Hana
Azuk	Kuhri
Teni	Züdi
Pokpu	Dphü
Ak	Apherü
Perangpong	Yongmüza
Ku	Rangshü
An	Ara
Kor	Yahvi
Ki	Mürü
Temokok	Nyü
Apu	Aha
Tu	Khünying
Shirong	Müle

Meja	Kuxüp
Ozü	Aqo

**Appendix L**

**Culture cues used in experiment 4**

Condition	Images
Congruent	
Incongruent	

## Appendix M

### English words and non-words used in experiment 4

Words	Non-words
Bone	Kone
Eyes	Eces
Crow	Crod
Door	Coor
Duck	Juck
Fish	Mish
Foot	Doot
Goat	Loat
Brain	Frain
Shoes	Snoks
Snake	Snape
Plate	Glate
Heart	deart
Horse	Gorse
Garlic	Farlic
Flower	Flober
Ladder	Laddel
Turtle	Curtle
Sickle	Wickle
Monkey	Ponkey

## Appendix N

### Ao words and non-words list

Words	Non-words
Nashi	Bashi
Waro	Caro
Kishi	Nishi
Batak	Natak
Pokpu	Mokpu
Ninok	Ninot
Meja	Mefa
Rong	Reng
Teret	Peret
Kaket	Kakem
Mebet	Melet
Napong	Nasong
Temebu	Tememu
Menden	Penden
Tekolok	Tenolok
Nhar	Nhor
Naro	Laro
Konger	Bonger
Aoso	Aono
Mapu	Madu

## Appendix O

### Ao and English word list used in experiment 5

Ao	English
Mapu	Monkey
Aoso	Sickle
Konger	Turtle
Naro	Ladder
Nhar	Flower
Tekolok	Garlic
Menden	Horse
Temebu	Heart
Napong	Plate
Mebet	Snake
Kaket	Shoes
Teret	Brain
Rong	Goat
Nashi	Bone
Waro	Eyes
Meja	Foot
Ninok	Fish
Pokpu	Duck
Kishi	Door
Batak	Crow

## Appendix P

### Ao and English non-words used in experiment 5

Ao	English
Kutri	Zilk
Manalu	Elrow
Kirong	Dread
Kewa	Kaby
Ahtuk	Watex
Sanmok	Peabut
Nolung	Millor
Zang	Wream
Nelang	Zake
Lanpen	Wotle
Kezi	Lekon
Bung	Talle
Molü	Cesk
Samken	Chim
Fang	Allond
Azong	Brikke
Jebok	Spune
Tebel	Spoom
Jawa	Caskle
Teda	Zear

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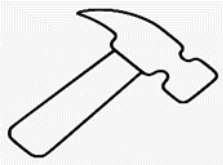


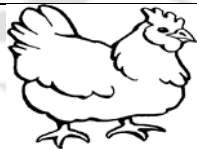
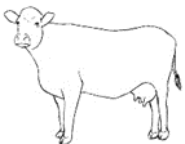

Thipo	Snife
Cilem	Krade
Frake	Jour
Tecang	Mheet
Mekong	Zood
Seku	Roxe
Kosang	Tuzip
Nirang	Trimpet
Litü	Laisy
Somono	Glodes
Mosok	Bamoon
Anko	Fuffin
Emtsü	Bashi
Temüng	Caro
Anüchi	Eces
Kubesü	Crod
Kone	Coor
Nishi	Juck
Natak	Mish
Mokpu	Doot
Abem	Sibna
Hüngi	Samel
Nodoro	Grafe
Hoya	Sarrel
Tzümo	Helt
Madu	Lamana
Laro	Wickle
Bonger	Ponkey
Aono	Baskel
Tenolok	Curtle
Nhor	Flober
Ninot	Laddel
Tememu	Farlic




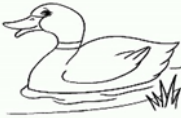



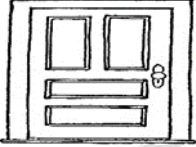




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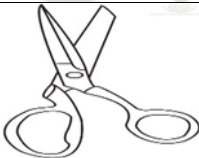

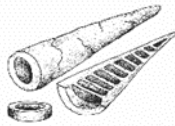


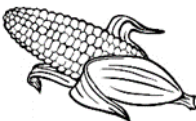

Penden	deart
Nasong	Gorse
Peret	Snoks
Kakem	Snape
Melet	Glate
Mefa	Frain
Reng	Loat

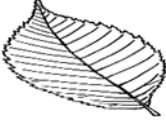


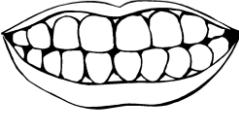
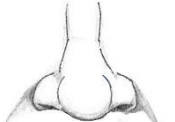





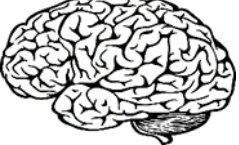
## Appendix Q

### Picture-word list used in experiment 8

Nagamese word	English word	Picture
1. Martul	Hammer	
2. Gojal	Nail	
3. Belcha	Shovel	
4. Murgi	Hen	
5. Guru	Cow	
6. Kuta	Dog	

7. Billi	Cat	
8. Maas	Fish	
9. Saguli	Goat	
10. Haas	Duck	
11. Gahuri	Pig	
12. Mochor	Mosquito	
13. Bisna	Bed	
14. Dorwaja	Door	
15. Naspati	Pear	
16. Mukuri	Peach	
17. Narikol	Coconut	
18. Bengana	Tomato	

19. Pias	Onion	
20. Gobi	Cabbage	
21. Adua	Ginger	
22. Chatta	Umbrella	
23. Kenchi	Scissors	
24. Hardi	Bone	
25. Bastenga	Bambooshoot	
26. Kitab	Book	
27. Charu	Broom	
28. Mokoi	Corn	
29. Saap	Snake	

30. Pata	Leaf	
31. Chuha	Rat	
32. Soku	Eyes	
33. Daat	Teeth	
34. Naak	Nose	
35. Chuli	Hair	
36. Bandor	Monkey	
37. Omita	Papaya	
38. Losin	Garlic	
39. Chabi	Key	
40. Dimaak	Brain	

## Appendix R

### Post hoc analysis of Group 1 combined error analysis

Contrast	estimate	SE	df	t.ratio	p.value
(L1-L2 Congruent) - (L2-L1 Congruent)	-16.320	30.9	3235	-0.528	0.7444
(L1-L2 Congruent) - (L1-L2 Incongruent)	14.626	28.4	3234	0.516	0.7444
(L1-L2 Congruent) - (L2-L1 Incongruent)	-35.877	30.2	3235	-1.189	0.7444
(L1-L2 Congruent) - (L1-L2 Neutral)	17.561	28.1	3234	0.626	0.7444
(L1-L2 Congruent) - (L2-L1 Neutral)	0.638	30.4	3235	0.021	0.9833
(L2-L1 Congruent) - (L1-L2 Incongruent)	30.946	30.9	3235	1.002	0.7444
(L2-L1 Congruent) - (L2-L1 Incongruent)	-19.557	32.5	3234	-0.602	0.7444
(L2-L1 Congruent) - (L1-L2 Neutral)	33.881	30.6	3235	1.106	0.7444
(L2-L1 Congruent) - (L2-L1 Neutral)	16.957	32.7	3234	0.519	0.7444
(L1-L2 Incongruent) - (L2-L1 Incongruent)	-50.503	30.1	3235	-1.676	0.7040
(L1-L2 Incongruent) - (L1-L2 Neutral)	2.935	28.0	3234	0.105	0.9821
(L1-L2 Incongruent) - (L2-L1 Neutral)	-13.989	30.4	3235	-0.461	0.7444
(L2-L1 Incongruent) - (L1-L2 Neutral)	53.438	29.9	3235	1.789	0.7040
(L2-L1 Incongruent) - (L2-L1 Neutral)	36.514	32.0	3234	1.142	0.7444
(L1-L2 Neutral) - (L2-L1 Neutral)	-16.923	30.1	3234	-0.562	0.7444

## Appendix S

### a. Ao-Sangtam mixed block post hoc analysis

Contrast	estimate	SE	df	t.ratio	p.value
(Congruent Mixed_L1-L2) - (Incongruent Mixed_L1-L2)	5.023	8.69	6485	0.578	1.0000
(Congruent Mixed_L1-L2) - (Neutral Mixed_L1-L2)	-8.820	8.67	6486	-1.018	1.0000
(Congruent Mixed_L1-L2) - (Congruent Mixed_L2-L1)	8.617	7.09	6486	1.215	1.0000
(Congruent Mixed_L1-L2) - (Incongruent Mixed_L2-L1)	13.640	11.26	6486	1.211	1.0000
(Congruent Mixed_L1-L2) - (Neutral Mixed_L2-L1)	-0.203	11.25	6486	-0.018	1.0000
(Incongruent Mixed_L1-L2) - (Neutral Mixed_L1-L2)	-13.843	8.69	6486	-1.592	1.0000
(Incongruent Mixed_L1-L2) - (Congruent Mixed_L2-L1)	3.593	11.17	6486	0.322	1.0000
(Incongruent Mixed_L1-L2) - (Incongruent Mixed_L2-L1)	8.617	7.09	6486	1.215	1.0000
(Incongruent Mixed_L1-L2) - (Neutral Mixed_L2-L1)	-5.227	11.23	6486	-0.465	1.0000
(Neutral Mixed_L1-L2) - (Congruent Mixed_L2-L1)	17.436	11.15	6486	1.564	1.0000
(Neutral Mixed_L1-L2) - (Incongruent Mixed_L2-L1)	22.460	11.21	6486	2.004	0.6771
(Neutral Mixed_L1-L2) - (Neutral Mixed_L2-L1)	8.617	7.09	6486	1.215	1.0000
(Congruent Mixed_L2-L1) - (Incongruent Mixed_L2-L1)	5.023	8.69	6485	0.578	1.0000
(Congruent Mixed_L2-L1) - (Neutral Mixed_L2-L1)	-8.820	8.67	6486	-1.018	1.0000
(Incongruent Mixed_L2-L1) - (Neutral Mixed_L2-L1)	-13.843	8.69	6486	-1.592	1.0000

**b. Ao-Sangtam Mixed block error**

Contrast	estimate	SE	df	t.ratio	p.value
(Mixed_L1-L2 Congruent) - (Mixed_L2-L1 Congruent)	29.60	115	235	0.257	1.0000
(Mixed_L1-L2 Congruent) - (Mixed_L1-L2 Incongruent)	110.18	105	235	1.049	1.0000
(Mixed_L1-L2 Congruent) - (Mixed_L2-L1 Incongruent)	-3.58	111	236	-0.032	1.0000
(Mixed_L1-L2 Congruent) - (Mixed_L1-L2 Neutral)	-51.79	125	235	-0.415	1.0000
(Mixed_L1-L2 Congruent) - (Mixed_L2-L1 Neutral)	53.58	126	235	0.425	1.0000
(Mixed_L2-L1 Congruent) - (Mixed_L1-L2 Incongruent)	80.58	116	237	0.696	1.0000
(Mixed_L2-L1 Congruent) - (Mixed_L2-L1 Incongruent)	-33.17	120	236	-0.277	1.0000
(Mixed_L2-L1 Congruent) - (Mixed_L1-L2 Neutral)	-81.38	131	235	-0.621	1.0000
(Mixed_L2-L1 Congruent) - (Mixed_L2-L1 Neutral)	23.98	132	234	0.182	1.0000
(Mixed_L1-L2 Incongruent) - (Mixed_L2-L1 Incongruent)	-113.75	111	238	-1.022	1.0000
(Mixed_L1-L2 Incongruent) - (Mixed_L1-L2 Neutral)	-161.96	126	237	-1.282	1.0000
(Mixed_L1-L2 Incongruent) - (Mixed_L2-L1 Neutral)	-56.60	129	240	-0.440	1.0000
(Mixed_L2-L1 Incongruent) - (Mixed_L1-L2 Neutral)	-48.21	131	238	-0.369	1.0000
(Mixed_L2-L1 Incongruent) - (Mixed_L2-L1 Neutral)	57.16	133	239	0.431	1.0000
(Mixed_L1-L2 Neutral) - (Mixed_L2-L1 Neutral)	105.37	142	237	0.741	1.0000

